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THE TRAINING OF TECHNICAL CHEMISTS.*

THE world's growth in manufacturing industries has increased enormously during the last century. This marked progress has resulted from a greater and more widely diffused knowledge of the sciences and their application. In this great advance the United States, aided by her wonderful and vast natural resources, has taken a very important part. In 1850 the value of manufactured products in the United States was $1,000,000,000. This has increased to the astonishing figure of $13,000,000,000 in 1900, while the value of unmanufactured agricultural products was estimated at $4,000,000,000.

In bringing about this increase, chemistry, assisted by engineering, has played a most important part. Our iron and steel industries, our whole field of metallurgy and, indeed, the majority of the great industries, would have remained in a crude, dormant state had it not been for the important work of the chemist and his more practical brother, the technical chemist. When we realize that the value of our manufactured products is three times as

* Paper read at the meeting of the New York Section of the American Chemical Society, February 5, 1904.

great as our agricultural products, it is plain to see the vast importance of the work of the chemist, and especially the technical chemist, in the successful operating, maintenance and improvement of our manufacturing industries.

It will be inferred from this statement that the number of chemists engaged in active work in this country has greatly increased. It is a fact that in the last thirty years they have increased in a proportion far beyond that of the increase in the value of manufactured products. It is interesting to note also that their importance is more and more recognized. Twenty years ago there were many establishments turning out manufactured products where no chemists were employed; these firms have since engaged chemists, with the result that a marked saving in the costs and improvement in the quality of the goods produced has been effected.

We are still very backward in this country in the employment of chemists when we compare our position with that of Germany, especially in the chemical industry itself. It is not uncommon in Germany for one concern (as in the Badische Anilin und Soda Fabrik) to employ over 400 chemists. We find in Germany that the highly educated technical chemists have done remarkable work in improving the chemical industrial condition of that country, placing it far ahead of all nations in many branches, such as the great coal tar color industry.

In the industrial strife which has been waging for some time between Germany and England, the former has gained on account of the fact that technical education is more widely diffused in Germany than in England. As an instance of this I quote an extract from the *Spectator* of December 5, 1903, being a reprint of a speech by Mr. Haldane before the Liberal League, wherein he explains that the industries of England have declined, not because the goods manufactured are kept out of foreign markets by protective duties, but because the goods themselves are inferior to those produced in foreign countries:

"The German manufacturers make a finer quality of cellulose than the English manufacturers. We have not yet succeeded in making it so white as they do, and for many of the uses to which celluloid is now put, whiteness is an essential quality. How did the German manufacturers set about obtaining this whiteness? 'Twelve of them,' says Mr. Haldane, 'combined together and put down £100,000, providing besides £12,000 a year, and in one of the suburbs of Berlin, near the great university, founded an institution which we have nothing like in this country. They had the most distinguished professor of chemistry they could get from the University of Berlin at the head of it; they gave him a large salary; they employed under him the best highly technically trained assistants that the university and the technical schools of Berlin could produce. * * * Whenever they had a problem, whenever they found that the British manufacturer was making his celluloid a little whiter, they said to their experts, 'Will you show us how to make ours whiter still?' The investigators were set to work and we were beaten nearly out of the field."

In this country there are numerous examples where the technical chemists have immensely improved manufacturing conditions either by lowering costs or by producing a higher quality of product. There is still much room for improvement, and I venture to say there is hardly a plant in the country turning out products requiring chemical skill where marked improvements could not be made by the very best work of technical chemists, in effecting changes that would reduce the cost of labor and

fuel, in recoveries from waste products or by producing better material.

Before deciding on the best methods of training our technical chemists, we must see that they are sufficiently educated in the proper lines to enable them readily to become technical chemists of great value. During my long experience in connection with chemical manufacturing and metallurgical work I have been forced to the full realization that the majority of chemists who are employed as analysts, technical chemists and as works or department managers, have perfected themselves in chemistry alone and seem to have neglected the importance of physics and engineering. If one wishes to achieve the greatest success in such work he should not undertake the problem at all unless he has made up his mind to perfect his mathematics and become thoroughly familiar with physics as well as mechanical engineering.

It seems a great mistake that the term technical chemist has been used in connection with chemists who are obliged to apply chemistry in manufacturing processes. It would have been better had they been called chemical engineers, for this might have induced the study of chemical engineering in the colleges many years ago. I feel certain that, had this been done, our industrial situation would have been much further advanced than at present, and the standing of practical chemists would have been higher and their value more highly esteemed than is the case. We do not speak of a metallurgist as a technical metallurgist, a miner as a technical miner, or an electrician as a technical electrician. The metallurgist is, properly speaking, a metallurgical engineer, the miner a mining engineer and an electrician who applies electricity, an electrical engineer. In all of these positions it is impossible to succeed without a full knowledge of mechanical engineering. The same is true in the application of chemistry. It would appear that when young men aspired to become chemists they looked upon the great chemists as supreme beings. They also considered mechanical engineering, with its machinery, machine shop, foundry, etc., as beneath the dignity of the chemist; they left college knowing nothing of mechanical engineering, and of course were totally unfit to take positions as works managers or wherever it became necessary to apply chemistry in a large way. I have known cases where young men, who were exceedingly clever as chemists, but totally ignorant of engineering and as unpractical as one could imagine, were placed at once in positions of practical responsibility in small chemical works. No more cruel act could possibly be done to the chemist. The business managers were not practical and had studied neither engineering nor chemistry. Of course many of the chemists who were placed in such positions proved utter failures, and for this reason many of the practical business men twenty-five years ago doubted the value of chemists in connection with manufacturing. Had these young chemists been chemical engineers and had the business managers received a moderate education in mechanical engineering and chemistry, the combination would have resulted in a marked success instead of failure.

When we notice the enormous field in manufacturing in this country one can not help feeling that the study of mechanical engineering should be very much more general than at present. I have known chemists who had not studied engineering, who, when placed on practical work, realized their deficiencies and took a course in mechanical engineering at night schools in order to enable them to properly apply their chemical knowledge. After men have gone through a regular course in chemical engineering they should be

trained, as far as possible, before leaving college in a thoroughly practical manner in the application of chemistry as well as in examples of engineering problems.

The greater the application of chemistry, the more important becomes the combining of mechanical training with chemical training. Our colleges should consider this matter more seriously than ever, and do their best to make the course in chemical engineering as complete and perfect in every way as possible. This is a duty they owe to our young men who desire to make a success in the great field of chemical engineering; it is a duty they owe to the manufacturers of this country who are doing their best to rival successfully the highest European competition and obtain our full share of the markets of the world for our manufactured products. Many of our manufacturers would receive the highly educated chemical engineer with open arms, and as a proof of their earnest belief in the importance of this matter they would gladly make necessary endowments to assist the colleges in carrying out this important work. The colleges should court their assistance by receiving all the practical suggestions that would enable them to readily turn out men so well educated and trained that they would very easily become valuable chemical engineers.

Chemical engineering necessitates a greater variety of engineering than all the other branches of engineering combined. In designing the apparatus that is employed in conducting the endless variety of chemical and metallurgical processes, every known metal and alloy is used in every conceivable variety or form. All kinds of brick are used, acid, basic, neutral and vitreous, glass, all sorts of pottery-ware, porcelain, stone, rubber, coke, asphalt, wood, cements, etc., and these in every combination and form which the best chemical engineering skill can devise to improve old methods and properly conduct new processes. In order to select the best material with which to carry on difficult problems, the chemical engineer must have a wide knowledge of the action of acids, alkalies and chemicals under all conditions of solution and heat, upon all known substances which could be employed to carry on the processes. Generally in new problems, carefully conducted investigations have to be made on a small scale, to show conclusively the best substances to be used.

In the designing and construction of plants and apparatus the chemical engineer has not only to select the most suitable material, but he must so carefully study the function of every detail of the apparatus to be used, that each part will successfully meet the full requirements. Each and every part must be proportioned to what it has to do; everything must be proportionately strong and large enough for the purpose, always avoiding unnecessary extremes in order to curtail the first cost of the plant. The desired end must be met in the simplest possible manner and the devices so arranged that while operating they will be so nearly automatic that good results will be achieved with the least possible labor. The plants must be so designed that the greatest yields will be obtained and the finest products turned out.

But after all this is done the chemical engineer will not be thoroughly skilful and up to date unless he designs every part of the apparatus so that it will last the longest possible time. Everything must be arranged so that when repairs are required they can be conducted with the least expense.

For the successful operating, maintaining and improving the condition of plants where chemical skill is employed, the manager or superintendent and his assistants

must be trained not merely in chemistry, but in mechanical engineering as well. Training in business and departmental management is also highly desirable. However perfectly a plant and its apparatus may be designed and erected, it will not necessarily give successful results unless every machine, furnace, still, condenser, tower, etc., is operated under the management of a man who is fully conversant with the function of every detail of the apparatus. In order to obtain in every way the best possible results, the superintendent is greatly handicapped if he has not received a full education and practical training in chemical engineering. Without the proper scientific knowledge that governs all the operations, he never fully understands the true reason for all the things that are done under his control. The inevitable outcome of such unintelligent management results in the continuance of a low standard of skill in all the working force under him. The apparatus is not run to the best advantage, thus lowering the quality and raising the cost of the goods produced. On the contrary, if the superintendent is properly educated in chemical engineering and has had a proper training as an assistant superintendent or practical investigator, and especially if he has a natural fondness for machinery and mechanics, then success will crown all his work. Whenever there is a difficulty—something breaks down and bad results follow—then he will at once clearly define the reason for the trouble and take the proper steps in completely correcting the evil. He gives true reasons for everything that is done in the various departments of the plant. He sees much going on that is unreasonable, and step by step he brings the unsatisfactory work up to a higher and higher standard. His assistants are chemical engineers, and he inspires great confidence and interest in them by a course of training that causes them to think and reason from every standpoint, so that before taking action, everything having an important bearing on the chemical, physical, engineering, business and labor sides of the problem in hand is most carefully considered.

By such a course of training the young men learn to think systematically and, guided by a master of the art, they rapidly learn to make the best use of their education in applying it to important practical work. It is quite natural for the impulsive youth to put into practice the first thought that comes to his mind. In the practical training that he should receive I must impress upon you the importance of making him consider every problem most carefully and from all sides, before taking action. In this manner he will acquire a habit of not acting quickly or without deep consideration. You will find that men who have thus been made to think and reason broadly and in a systematic manner, will put into practice what may be considered good sound judgment. Such men are bound to make a success in the practical application of their chemical engineering.

In a large chemical or metallurgical works, or any other establishment where the processes are controlled by chemical analysis and where the raw and finished products are bought and sold for values governed by analysis, it is necessary to have a well-appointed chemical laboratory. In large plants where many chemists are employed, an able chemist should be at the head of the analytical as well as the research laboratory; the chemists in the analytical laboratory are not always college graduates, as most of the work is of a routine nature, requiring great skill in manipulation but not necessarily an extensive knowledge of chemistry. These men, when confined to this work, have no opportunity to employ engineering skill ex-

cept in perfecting the apparatus used in making chemical analyses. It is of the utmost importance that their analyses are accurate and quickly performed. On very important work, such as analyses made for settlements on raw material and finished products, analyses are run in duplicate and settlements made on a split between the buyer's and seller's results. This competition encourages very accurate work on the parts of the analysts, and they become very skilful.

It is the custom in all well-managed industrial laboratories to investigate frequently the analytical methods used, in order to determine their accuracy, reliability, ease and quickness of performance. Old methods of analysis are thus improved, new methods invented and the new methods of others compared and adopted, if found the most suitable. For this reason it is not uncommon to find the most desirable analytical methods used in the laboratories of our important industrial establishments. The colleges would do well to look into these methods as far as possible, and thus keep abreast with the best practice to aid them in teaching analytical methods.

There is no reason why the training of analysts in large laboratories should not be of the highest order. It is a great mistake to allow the standing of the work done in these laboratories to run down. It is a grave error to economize too much in the laboratory by employing too few analysts and thus prevent the practical managers from receiving all the information required to control intelligently the various processes in the factory.

After men have been a few years in an industrial laboratory they, as a rule, desire positions in the works. It is the exception when we find a chemist from college who has studied mechanical engineering; for this reason only very few chemists become good candidates, qualified for giving proper attention to large factory processes where the many complicated devices require engineering as well as chemical skill. I have known many of the men in a laboratory to study mechanical engineering either at night schools or with correspondence schools. It would have appeared the part of wisdom for such men to have taken a course at college in mechanical engineering as well as in chemistry, thus fitting them for a wider field of work in their chosen vocation, and affording an opportunity to make greater advancements.

The future success of any well-established industrial institution of a chemical nature is in grave peril if it does not have an investigation or research department. The manager of this department must be by education a chemical engineer. He should have had much experience as a practical business manager of plants, and a direct acquaintance in the designing, reconstruction and repairs of the same. This department must have a properly equipped research laboratory. The head of this research laboratory must be possessed of very high attainments as a chemist and physicist, with a fair knowledge of mechanical engineering. His work through life will be stamped with the greatest success if he has been trained at college in methodical methods of thinking, as applied to original work, and to many examples of practical investigation and experimentation. The chemists under him should have received the same education and training at college. It is desirable that this department should have the capacity to investigate new processes that are presented, and if they look promising, a small working plant should be constructed and operated by them to prove fully the value of the method and to give the necessary practical data to be used in the designs of a large and fully equipped plant. This department will keep in touch with every-

thing that is published, in either technical journals or patent reports, having a bearing on the work under consideration. All the processes in the company's works will be carefully investigated by them, to locate and devise means for preventing losses in gases, liquid and solid waste material, and thus increase the yield of the useful products. They work up methods for making useful products from waste material. Much of their time is occupied in working up means for improving the quality of the various finished products. They are also busily engaged in working up new processes, putting the same into practice, and thus entirely supplanting the old methods.

It will be seen from these remarks that to become a skilful or trained investigator in a research chemical laboratory requires:

1. A proper education at college as a chemical engineer, especially full in chemistry.

2. Training at college in original thought as applied to practical investigation, and to working up and improving processes.

Some of you feel that it is a mistake to divide the work of one man between chemistry and mechanical engineering; that the chemist must be solely a chemist and the engineer an engineer alone. I admit that a very small proportion of the chemists have to devote all their time to pure chemistry, and in certain lines of theoretical and research work. The great majority of chemists in this country, however, are engaged in practical work where they need engineering assistance, and in such cases the chemist who is not an engineer would have to consult the engineer for practical advice, and the engineer seeks chemical assistance from the chemist and without a knowledge of chemistry obtains but little satisfaction.

My experience forces me to feel that a complete understanding of the various problems must come from a brain that can think in both chemistry and engineering. The dignity and fame of chemistry will not be injured by joining in close union with engineering. Indeed, the real value and glory of chemistry come from its application to useful products that add comfort and happiness to the human race. These applications can not be carried on without the aid of engineering.

Applied chemistry would be greatly benefited in this country if the colleges would come in closer touch with the manufacturer. The professors of chemistry and mechanical engineering would do well to study more carefully the educational requirements as found in some of our large works, where the advantages of a well-directed knowledge of chemical engineering are clearly shown. I am sure the broad-minded manufacturers would gladly cooperate in this important work, seeing plainly that it must result in a general advantage to our industries, and to the industry and prosperity of our whole country. The best way to carry on this work would be to employ a plan that has been in successful practice at Brown University for the last few years. They carefully select from their alumni a separate committee for each department of study. These committees visit the college once or more a year; they consult and exchange views with the heads of the departments they represent. Each member reports his recommendations to the chairman of his committee, who incorporates the same in his report to the president of the college. I am a member of the committee appointed to assist the chemical department of Brown University. I recommended to them to have a course in chemical engineering, and, indeed, outlined a four-year and a five-year course, giving the number of hours per week for each study.

The more perfectly and completely chemistry is applied by engineering assist-

ance, the greater will be the volume of manufactured products and the larger will be the field for chemistry. May Americans stand foremost among the nations of the world in turning out chemical engineers having such great ability that they can easily lead our manufacturers to an unapproachable pinnacle of greatness and perfection. May the chemists of the American Chemical Society ever be leaders in this great work, and may their name and fame remain to the end of time a living monument to industry, progress and prosperity.

J. B. F. Herreshoff.

DISCUSSION.

Mr. T. J. Parker.

It seems to me the keynote of the discussion was struck by one sentence in the address, which was to the effect that the marvelous development of industrial chemistry in this country is due to the work of the chemical engineer. I do not see from my standpoint how the dual existence of the engineer and the chemist is necessary for the higher development of the chemistry and mechanics of the industry committed to the charge of the competent technical chemist. The important question arises, therefore, What shall we do to properly equip the young men who are annually turned out from our technical schools and colleges?

From the experience of many here present they could no doubt tell you of men who have been brought up in mechanical pursuits, not as chemists, and whose practical knowledge of chemistry was acquired after they had left college, who have made very successful men, because they had mechanical ability to apply the investigations and discoveries of the scientific chemist to the requirements of the manufactures or arts under their charge. If the application of chemistry to manufacturing processes is desired, it is certainly necessary for these young men to have a knowledge of mechanics or engineering as well as chemistry, in order to apply it efficiently in our factories.

The opening for the industrial chemist in the next five or ten years is simply phenomenal, judging from what we have heard here to-night.

Mr. M. C. Whitaker.

On the technical staff of a manufacturing establishment you will find a civil engineer who lays out the grounds and devises new construction, and you will find a mechanical engineer who plans his boilers and his new engines; both of these men, in the opinion of the superintendent, are very important individuals. The electrical engineer sets up his dynamos and places his motors. He devises new and ingenious electrical apparatus, and he, in the mind of the superintendent, is also a very important individual. Now, when the processes connected with these manufacturing industries are referred to the chemist for improvement, he repairs to his laboratory, and we all know that he goes through some very serious, painstaking work. This work is not appreciated by the superintendent because he is not a chemist. What the superintendent asks for is actual merchantable results. The chemist is generally not a man who is capable of transmitting from a laboratory to a factory the ideas which he has developed. He is not educated in the engineering branches which have been so much emphasized here this evening. He should have a knowledge of electrical engineering and bring it to bear in the proper solution of problems coming before him. He should have such a knowledge of mechanical engineering as to bring to bear the best mechanical devices. Furthermore, and in my mind the most important of all, he should have that knowledge of getting along with

people so developed that, after he has prepared his plans and laid them out, he can get the help to bring about the results which he desires. This is a very important step, but the point I have tried to make is that the man must not only have the knowledge to develop new ideas, but he must have the knowledge to put them into practise. Now, we see that those men who have by themselves obtained this engineering knowledge, either before or after studying chemistry, are the men who make a fair success. Therefore, it seems to me very important that we should do all we can to help to produce the kind of a chemist that I have named—a chemical engineer. A man who has such a knowledge of chemistry, of electrical and mechanical engineering, of metallurgy and of the handling of men as will enable him to go into a laboratory and develop a process, and then put it into operation and deliver to his concern a merchantable result, will have that recognition on the payroll which he deserves. In other words, I think that these men, instead of being assistants in our manufacturing industries, will be leaders.

DR. WILLIAM MCMURTRIE.

Those of us who have had experience in the applications of chemistry in a large way have long recognized the truth that to be successful in the chemical industries in this country one must be at the same time a chemist and an engineer. One must know thoroughly not only the reactions involved in a particular industry and the laws of chemistry which govern them, but must have intimate acquaintance with the mechanical means whereby the reactions may be carried out in a large way.

I know full well that teachers in the educational institutions object that the time allotted for the training of young men for the chemical industries is too short to cover both the branches of work indicated, and most or all of us are prepared to admit that this objection is valid. Part of the difficulty is due to the fact that those charged with this training have to do with raw material in the student which is far too raw; that students present themselves not properly prepared for the work before them. I, therefore, believe that the training of the technical chemist, as well as that of every technical and professional man, should begin much earlier than the entrance to the technical school. It should begin even in the earlier grades of the primary school. Here the idea should be abandoned that the young minds are too immature for serious study and systematic work; that the children need to be amused rather than seriously educated; that they must be trained by kindergarten methods in lines which must later be traversed again in the serious struggle for education. And thus precious time is lost at the age when the mind is most pliable and receptive.

It would be far better to return to the old-fashioned methods of careful study of the three R's. The children should be taught first of all to read understandingly; to write clearly; to comprehend readily the great truths of literature and science, whether expressed orally or in print. Then they should have continued training in mathematics, the successful study of which involves careful and systematic thought and work. The result sought in any calculation in mathematics is always most definite, and the attainment of an accurate result involves careful attention to every detail. For this reason the study provides splendid preparation for successful work in any profession or in business, in the research laboratories or in the wider fields of the applications of science—the great manufacturing and engineering works.

So then let the children begin serious and systematic work early; let them be so trained that work once done need not be repeated; let them come to the technical

school with thorough and careful training first, in general culture, in language and literature, then in mathematics, and finally give them the advantage of the splendid courses provided in our technical schools in chemistry and engineering, and they will be prepared to meet effectively and successfully the great problems the chemical industries of the immediate future will have ready for them. That what is needed can be fully accomplished in a course of four years I doubt, but it may be helped by the preparation I have outlined. That the technical chemist of the future must know thoroughly the great laws of chemistry and at the same time be well grounded in the principles of engineering I do not doubt. And I am satisfied that justice to the young men, as well as to those who must employ them, demands that time for all the training I have outlined should be provided.

Professor Edward Hart.

It seems to me that we must in the first place reconcile ourselves to the idea of doing the best we can in four years. I am one of those who do not believe very much in post-graduate courses for chemical students. There are many who must have a post-graduate course, of course, but if you take the ordinary man and follow the history of such ordinary man, the man who passes through college and makes afterwards a success, you will find that very many of them were poor boys. They haven't the money to take more than a four years' course. If we are to turn out such men we must educate them, as far as we can, in four years. How are we going to do it? We must limit the number of our subjects. We must attempt and to a large extent succeed in teaching those things that we attempt to teach well and not attempt to teach too many things, and that involves a very careful selection of one part of the equipment to which I am sure too little attention is often paid, and that is those who take part in the work of teaching. I have had considerable experience in teaching. I have had very few assistants who did their work faithfully, very few. It is a very tiresome, thankless business to teach a lot of beginners, and it very seldom happens that before the end of two years of such work the man doesn't lose a part of his enthusiasm and do his work less well than it should be done. This work must be done well if we are to succeed in turning out the class of men that we want, and it is this work which determines very largely the quality of our product, for there is no truer thing in the world than that the student is largely the product of the self-sacrifice of his teacher. We must first teach the science of chemistry, so far as it is possible, and we must teach it thoroughly and well, because we can't go too far, and then we must teach engineering, because the chemical manufacturer is an artisan. He must be an artisan to a certain extent. I do not believe, however, that in the four years' course it will be possible to get into such a man more than the elements of engineering, but if these things are done well I am quite sure that the product will be quite different from the product that is turned out at the present time.

Professor W. A. Noyes.

The discussion thus far has dwelt almost exclusively upon the necessity that the chemist should know many things besides chemistry and especially that he should know mechanical engineering, and with all that phase of the discussion I most heartily agree.

With regard to the chemical side of the work we are in as great difficulty, almost, for lack of time as with regard to the accessory side of it. Chemical science has expanded enormously in the last twenty-

five or fifty years. It is as impossible to-day to know all chemical science, even in a general way, as it was fifty years ago to know all the sciences. Chemistry has so wonderfully developed in so many different directions that it is impossible for any one to cover the whole field. It is necessary, therefore, for the colleges to choose, in this large field, what shall be taught. Now, the basis of the training for the technical chemist and for the chemist of all kinds, must be a thorough training in analytical chemistry. I believe that the training in this particular field has become inferior to what it was a few years ago. Results that have come to my knowledge, and no doubt to the knowledge of others of you, during recent years, of the way in which chemists fail in comparatively simple analytical problems, show that the training of the chemist is not always what it should be. Another important question which comes before the teacher in the college is, How much training in industrial chemistry can be given to the student. It seems to me that comparatively little in that particular direction can be done, especially in a four years' course. It is important that the student shall have a thorough training in the fundamentals of the science and a thorough training in analysis. If that training is given, it is impossible to crowd into the four years' course any very considerable training in industrial questions. Another fact which makes any long or extended training in industrial questions inadvisable, as well as impossible, in the college course, lies in the extremely wide range of work in which these young men are going to engage, and, in a majority of cases, from the difficulty of telling what work the particular individual will do after he gets out of your hands. It is manifestly impossible, therefore, to train him for that particular field into which he will go. He must of necessity gain his special training in that field after he enters it.

PROFESSOR C. F. CHANDLER.

The difficulty is that our students come to us for four years. They never know what particular branch of chemistry they intend to pursue in after life. We are compelled, therefore, to treat them all substantially alike, and give them all substantially the same chemical education. Now, it is not possible in four years to do a great deal more than to lay the foundations of a chemical education, particularly if you want to devote some time to giving the students a good training in mathematics and various other branches which go to make up a complete chemical education. It seems to me as if the work of making the chemist was put entirely upon the instructors. The student expects the instructors to do the work. We suggested that we might increase the number of assistants, and let them make the analyses for the students. When I was a student I went into Wöhler's laboratory. He gave us a lecture every morning and we were expected to attend that lecture and make the most of it. Then we went into the laboratory. He handed me a piece of triphyline and said: 'I want you to get some lithia out of that.' He did not give me an hour's lecture and tell me how to make lithia and have me write it down. He gave me a piece of the mineral and I had to hustle and find the solution of the problem myself. He said: 'You have to make some lithia out of that, and after you have made up your mind, come to me and I will look over your proposition and see whether it is right.' That was the way chemistry was taught in Wöhler's laboratory. There was a small number of students and that method of instruction was carried out. We had seven hundred students working in our chemical laboratories

last year, and, of course, it is extremely difficult to give each student much personal attention. I think that one great difficulty is that somehow or other we have rather drifted into the condition that the student expects the professor to tell him everything that he has to do. I worked in Rose's laboratory for a year, making mineral analyses. He never told me how to make an analysis. He handed me a piece of mineral, samarskite, for example, and told me to find it out myself. I read everything I could find that had ever been written on the subject. I found out the best methods known for analysis. That was the system of those days. Now, the students expect us to stand up in the lecture room and tell them every step in the process of making an analysis. They must be told to weigh a gram and a half of this, and add this and that to it, so many cubic centimeters of this and so many of that, and they must do this, that and the other thing; and unless you tell the student every step of that kind, he can not make the analysis.

I quite agree with everything that has been said upon the subject of adding to the instruction of the chemist a sufficient amount of engineering to enable him to rise to the dignity of superintendent or manager of large works, but I do not think that can be done in a four years' course. If we train our men in analytical chemistry, in general chemistry, and in such an amount of industrial chemistry as can be taught in the lecture room, and such an amount of laboratory practice as can be carried on in university laboratories, and at the same time give them their thermodynamics and physics, and a certain amount of mineralogy, I think that is the best we can do.

Professor A. A. Noyes.

In the first place I would say, I believe that a distinct demand by manufacturers for men trained in both chemistry and chemical engineering will make it much easier to induce students to take the extra fifth year that is necessary in order to do anything like justice to these two subjects. I believe, too, that institutions can do a great deal in this direction by laying out a definite course of fifth-year work, leading to some higher degree; for when a definite course is offered there are more likely to be applicants for it than if it is only stated in a general way that there is an opportunity for advanced work.

I should also like to ask the question, whether manufacturers prefer a chemical engineer or an engineering chemist—that is to say, a man whose education is mainly upon the mechanical engineering side, with some knowledge of chemistry included, or a man whose main training is in chemistry, this being supplemented only by such an amount of mechanical engineering as can be worked in without serious detriment to his chemical knowledge? I think it should be borne in mind in answering this question that, if the chemical engineer is preferred, it would certainly mean a sacrifice of the power of attacking new problems on the part of our industrial chemists. The engineer is trained to put in application existing methods; and it seems to me that what is wanted of the factory chemist in this country is rather the power of solving new problems and of making improvements in processes—a power to be acquired far more by a good chemical training, which should include a large proportion of research and other work requiring independent thinking, than by an engineering training.

In order to introduce any considerable amount of mechanical engineering in the chemical courses it is necessary to eliminate something that we have there now; and the question is a very pertinent one, What kind

of instruction can be best spared? By two of the speakers analytical chemistry has been emphasized as especially important, a subject to which already by far the larger part of the available time is devoted in most chemical courses. I myself consider it a question whether this can not be reduced to a considerable extent in the case of chemists preparing for positions in the works rather than the laboratory. Another question that may, perhaps, be worthy of consideration is whether the modern languages to which a very large amount of time is devoted in most of the college courses are actually made use of to any considerable extent by manufacturing chemists.

PROFESSOR H. P. TALBOT.

We can not probably hope to transform the student into a chemist and an engineer in the same four years, but we can hope, I think, to turn out a good chemist—a man fundamentally trained, at any rate—and at the same time to give him so much of the fundamental principles of engineering that he will at least know what a mechanical engineer is talking about and know what he ought to be expected to do. That is a good deal in itself.

As to what shall be taken out of our chemistry courses to make a place for these other subjects, there must always be a certain amount of sincere difference of opinion. While analytical chemistry is the yard-stick by which the chemist generally measures his practical attainments, it is possible, I think, that we sometimes make a mistake in teaching analytical chemistry in a too abstract way. I am hopeful that, as time goes on, we shall be able so to arrange our courses that we can connect analytical chemistry in the mind of the student more closely with the scientific or industrial problems to which it is to be applied, and in this way can stimulate his interest and develop his ingenuity. If a change of this sort will produce a graduate with greater power to apply his knowledge and technique promptly and practically, the time spent upon analytical chemistry will be fully justified.

DR. WM. JAY SCHIEFFELIN.

I want to say a word in answer to the questions which Dr. Noyes has put—first, should less time be devoted to analytical work; and second, are the languages important?

Most of the industrial processes are elaborations or applications of methods used in analysis; therefore, the technical chemist should know the methods. It is very hard to-day to get a man who is a good analyst, upon whose analysis you can entirely rely. If he must make an analysis which he has not made before, he takes a book of selected methods and goes through it, but his results are not satisfactory. I think it is vitally important that the man should be a trained analyst. It is the hardest thing in the world to have a mineral accurately analyzed to-day and there are very few men in the country who can make an analysis of a new mineral from which its formula can be deduced. But what interests the chemist in the technical laboratory is improvement in processes and apparatus more than in minute accuracy of results; moreover, in any technical laboratory there are comparatively few varieties of analyses being made. It seems to me that the German language is immensely important, because the German works, Beilstein and Dammer, are to-day the chemist's bibles, and contain nearly everything on organic and inorganic chemistry which he wants to learn about, and they haven't their parallel in the English language. It is, therefore, very important to have a knowledge of the German language, and I do hope there will be no at-

tempt to reduce the amount of time given to quantitative analysis.

Dr. Hugo Schweitzer.

Until now we have been a happy family and I hate to sound the discordant note. I am absolutely against the introduction of chemical engineering in the education of chemists and want to restrict the same to pure chemistry. You have heard from Professor Chandler and from Professor Noyes and the other gentlemen who are teaching at our universities and colleges that it is impossible to make a chemist and a chemical engineer in four years. This is not to be wondered at, as Mr. Herreshoff stated in his paper, and it was this that struck me most, that chemical engineering embraces more kinds of engineering than any other branch of engineering. Now, since he, the most successful, the most ingenious, the most prominent chemical engineer in this country, has been able to master both sciences, he thinks that we average people of little brains and little minds should also succeed. Gentlemen, the proof of the pudding is in the eating. Let us be open and frank! What have American chemists originated in chemical manufacturing? You will find that we have been pioneers in only a very few instances. It is true we manufacture acids and alkali just as well and perhaps better than they do in Europe, but, as I say, we have been pioneers only in a few things, and the reason for it is in our method of education. Who asks that we should be both chemists and engineers? Do we chemists ask for it? No, we have trouble enough with chemistry. Do the teachers of chemistry ask for it? No, because they tell us to-night that it is impossible for them to convert their students into chemists and chemical engineers. You remember Dr. Noyes said that 'to-day chemical science requires as much detailed knowledge as did all sciences together fifty years ago.' Do you think that with such a broad field we can also master chemical engineering? Most decidedly not.

It is the manufacturer who asks that we should be both chemists and chemical engineers. In my opinion, the education of the chemist, gentlemen, is entirely a secondary question. As far as they are not educated chemically, it is the employers of chemists who need education. They engage a chemist, and paying him the generous salary which we chemists are wont to get, they think he ought to be a chemical engineer besides. What the manufacturers ought to do is: they should take the graduates from the universities as they are educated in pure chemistry and train them in their works at their expense during one or perhaps two years to become technical chemists and technical engineers. So, gentlemen, I urge upon you most sincerely to abandon the idea of educating chemists to be also chemical engineers, and now let us all work for the education of the chemical employer and the capitalist.

Mr. Maximilian Toch.

A student can study languages before he enters into his course of chemistry. German is essential, but French is not. When a student is admitted to college he is about seventeen years of age and he should then have a fundamental training in mathematics and languages; in fact, at the age of seventeen a student can be fairly well trained in elementary chemistry and in mathematics and drawing, so that the four years at college can be applied to chemistry, physics and electricity.

My suggestion would be that the colleges invite men to lecture who have been successful in manufacturing industries and they naturally can impart knowledge to students such as a professor is not expected to have.

The college laboratory is totally different from a factory. Any student can make an ounce of a material, but when it comes to multiplying that by three thousand technical education is necessary.

PROFESSOR M. T. BOGERT.

It appears to me that the employers of technical chemists really want two kinds of chemists. In the first place, they need what may be called technical directors; men who are trained more thoroughly on the mechanical side than on the chemical side; who understand the handling of both men and machinery and who know in a general way the chemical processes to be carried out; and secondly, scientifically educated chemists. The training of these two classes of chemists, it seems to me, is quite different. The man who has to do with a particular chemical problem and work it out in the laboratory needs a very thorough and highly specialized training in chemistry. Engineering is not necessary. The value of the results accomplished have been placed too much, in my opinion, to the credit of the technical director. The man who is working in the laboratory, the man behind the guns, is the man who has accomplished results in Germany as well as in this country. I think the progress in Germany in technical chemistry has been due largely to the work in the research laboratories by men who have no engineering training, and I plead with the employers for recognition of the work of the men in the laboratories and for greater patience in their dealings with them, and for a more enlightened policy in establishing research laboratories, for, in my opinion, it is only through such establishments that the American chemist can hope to compete with the German chemist.

MR. W. H. NICHOLS.

The young man who goes to college to get his technical training should determine whether he is going to use it in the realm of pure research or whether he is going to be a chemical engineer. The mechanical engineer can not take the place of the chemical engineer, as he goes to the other extreme. We have already the purely scientific chemist and the engineer; between the two we have the technical chemist or chemical engineer and there is plenty of opportunity for him.

It should be remembered in this connection that a college course is simply a foundation, on which the further education is to be built in after life; for it is not possible to furnish the thoroughly educated man in four or even in five years.

SCIENTIFIC BOOKS.

Skew Frequency Curves in Biology and Statistics. By J. C. KAPTEYN, ScD., Professor of Astronomy at Groningen. Published by the Astronomical Laboratory at Groningen. Groningen, P. Noordhoff. 1903.

This paper is almost unique in that it attempts to be at once a popular presentation of statistical methods and a mathematical derivation of a new theory regarding skew frequency curves, thus attempting to 'benefit all students of statistics' by his ideas. It is only necessary for the non-mathematical reader to take his mathematics for granted and apply the formulæ deduced, while the mathematician need not waste much time over the first ten paragraphs.

The author mentions how Francis Galton has shown that important biological conclusions may be derived from a discussion of the normal curve, and deplores the fact that most of these deductions can not be extended to the skew curves of Quételet and Pearson. This, he says, is due to the purely empirical nature of these curves; they furnish a mechanical representation of the data without having any real and vital relation to them. The advantages claimed for the new theory are: "(*a*) It assigns the connection between the form of the curves and the action of the causes to

which this form is due; (*b*) it enables one to reduce the consideration of any skew curve to that of the normal curve; (*c*) the simplicity of the application."

A popular discussion of the origin of normal curves follows. The curve, as is well known, is given by the expansion of $(1/2 + 1/2)^n$. Professor Pearson derives his skew curves by studying the expansion of $(p+q)^n$, where $p+q=1$. Now Professor Kapteyn considers the exponent n as giving the number of causes which enter into the problem of growth, and shows that with a sufficiently large value for n, and natural causes must be looked upon as almost infinite in number, $(p+q)^n$ approximates closely to a normal curve or, quoting Bessel: "Whatever be the effect of the various causes of deviation, as long as they are: (*a*) very numerous; (*b*) independent of each other; (*c*) such that the effect of any one cause is small as compared with the effect of all such causes together, we shall obtain a curve which approximates the nearer to the normal curve the greater n is."

But, though we may assume the effect of certain causes in producing deviations in certain quantities x to be independent of the value of x, this can not be the case with quantities proportional to x^2, $1/x$, or any non-linear function of x. The resultant curves under these conditions are the skew curves. To obtain these the author supposes that 'on certain quantities x, which at starting are equal, there come to operate certain causes of deviation, the effect of which depends in a given way on the value of x.' Let us imagine certain other quantities depending on the quantities x in the way given by $z=F(x)$.

Then we have

$$\Delta z = F'(x)\Delta x, \text{ or } \Delta x = \frac{\Delta z}{F'(x)},$$

where Δz represents a series of deviations of the quantity z independent of the value of z. Thus the effects of the causes of deviation operating on x are proportional to $1/F'(x)$. Now since, according to assumption, the quantities z are distributed in a normal curve, say

$$y = \frac{h}{\sqrt{\pi}} e^{-h^2(z-M)^2},$$

the quantities x must be distributed along the curve

$$y = \frac{h}{\sqrt{\pi}} F'(x) e^{-h^2(F(x)-M)^2}.$$

This is the frequency curve generated under the influence of causes, the effect of which is proportional to $1/F'(x)$, no limits being placed as to the form of this function.

The author next takes up the case

$$F(x) = (x+\kappa)^q$$

the equation of the curve now being

$$y = \frac{Ahq}{\sqrt{\pi}} (x+\kappa)^{q-1} e^{-h^2[(x+\kappa)^q - M]^2},$$

and derives complete formulæ and tables for the finding of the five constants A, h, M, q, κ for the five possible cases

$$q \gtreqless 0 \text{ and } q = \pm\infty.$$

The solution is left in a rather unsatisfactory state, as we can not find A directly, while it is necessary to know A in order to find the other constants. As A is in most cases unity, he assumes this value for it, and computes the other constants. These having been found, A is readily computed. If A computed $\neq A$ assumed, try again with some other value for A until a perfect agreement has been obtained. Another weakness of the solution is that only four of the observations of a set are used. These are so chosen that their abscissæ are in arithmetical progression. The author, however, considers this very fact an element of strength.

It can not be denied that Professor Kapteyn gets some very good results and his theory is undoubtedly full of possibilities.

C. C. Engberg.
The University of Nebraska.

The Mammals of Pennsylvania and New Jersey. A Biographic, Historic, and Descriptive Account of the Furred Animals of Land and Sea, both Living and Extinct, Known to have Existed in these States. By Samuel N. Rhoads. Illustrated with plates and a faunal map. Philadelphia, privately published. 1903. Pp. 252.

Mammalogists have been so busy in recent years describing, classifying and getting their

work on a sound systematic basis that few exhaustive studies of the mammals of limited areas have been made. The 'lay ornithologist' thrives throughout the United States. By his enthusiastic local work he has contributed largely to the present high state of knowledge of the birds of the whole country. Interest in mammals, however, has been lamentably slight, except among professional workers connected with museums. Mr. Rhoads's work on the mammals of Pennsylvania and New Jersey is a valuable object lesson for those who refrain from attempting local studies of mammals on the supposition that there are no opportunities for non-professional workers. The book, however, is not primarily non-professional, nor can Mr. Rhoads be called a 'layman,' but the amount of interesting and valuable data he has gathered in a comparatively limited region is very suggestive of what might be accomplished by local students elsewhere.

The book takes the form of a list, with each species fully treated under several subtitles, such as faunal distribution, distribution in Pennsylvania and New Jersey, records, habits and economic status, and description of species. In addition to the recent species and subspecies, which number 96, a list of 95 which occur in the fossil state is given, and also a brief hypothetical list. Introduced exotics are likewise enumerated. The large list of recent forms, which in many cases includes two or more related subspecies, is swelled by 18 species of whales and dolphins found off the coast of New Jersey.

Besides being an accurate list of all the mammals known to occur within the boundaries of Pennsylvania and New Jersey, the work is of importance and interest in its bearing upon the history and habits of many well-known mammals. The accounts of species now extinct in the two states, such as the wapiti, the bison and the beaver, are of especial interest. The notes on habits are entertainingly written and will be found interesting alike to the ordinary reader and to the professional naturalist. The author's own observations, which are stated to have covered a period of eleven years in the region, are freely given, but considerable quoted matter is also included. This is taken largely from correspondence with old residents of various parts of the region. The reliability of such sources is of course doubtful, but the notes are evidently given for what they are worth. In one case, after a quotation of several pages, the fact is brought out that the narrator 'was in the habit of making a good story of his exploits.' Nevertheless, such information is valuable, and this method almost the only one for obtaining an idea of conditions no longer existing. As far as possible, primitive conditions have been contrasted with those of the present, with particular reference to the influences of settlement and deforestation upon the existence and distribution of the native mammals. When these processes have progressed still further, the value of this work in carefully setting forth present conditions will doubtless be appreciated by future students. Distribution is usually stated in terms of life zones. A religious correspondence of the ranges of the mammals with the zones is implied throughout. Indeed, some subspecies are included solely because the zone they are supposed to inhabit is known to extend within the boundaries of the region. The extent to which such distributions are theoretical is not emphasized. In this connection there appears to have been an opportunity for a suggestive outline of desirable confirmatory work for the future.

The nomenclature and technical treatment throughout are according to the most recent knowledge and standards. In several instances names in common use by others are slightly changed, but it is to the author's credit that the reasons for so doing are always stated, even if they merely amount to personal opinion. In one case, to which my attention has been called, a name has been wrongly applied, that of a domestic animal, the so-called Belgian hare, which should be designated as *Lepus cuniculus*, not *Lepus europæus*. Questions of doubtful relationships are discussed in some cases, and in this connection occasional disparaging allusions to 'the hair splitters' occur, as if to lead the unsuspecting reader to the belief that the author abhors such.

The book is illustrated with nine full-page plates, chiefly photographs of specimens. A double-page colored map of the life zones of the two states is also given. Since this is the most detailed zonal map of the region yet published, and since it differs in some respects from previous inclusive maps of smaller scale, it is regrettable that more space was not devoted to discussion of life zones and especially to the boundaries as indicated on this new map. It is also unfortunate that the colors are not those which from repeated use on other maps have become associated with the several zones. As a piece of book-making, the work is not all that might be desired. The paper is rather poor and errors in typography are not infrequent. Minor shortcomings, however, may easily be overlooked in such a good and useful book. It is a thorough exposition of the knowledge, past and present, of the mammals of the two states, and may be safely ranked among our most important works on the mammals of eastern North America.

Wilfred H. Osgood.

SCIENTIFIC JOURNALS AND ARTICLES.

The last number of *The Journal of Infectious Diseases* contains the following articles:

Alice Hamilton: 'The Toxic Action of Scarlatinal and Pneumonic Sera on Paramœcia.'

C. P. Clark and F. H. Batman: 'Pneumococcal Bronchiolitis (Capillary Bronchitis).'

E. H. Ruediger: 'Improved Technic of Agglutination Test in Typhoid Fever—The Use of Formalinized Cultures.'

Roger G. Perkins: 'Bacillus Mucosus Capsulatus: A Study of the Group and an Attempt at Classification of the Varieties Described.'

Mary C. Lincoln: 'Agglutination in the Group of Fluorescent Bacteria.'

Edward C. Rosenow: 'Studies in Pneumonia and Pneumococcus Infections.'

Joseph Louis Baer: 'Epidemic Gonorrheal Vulvo-Vaginitis in Young Girls.'

Earle B. Phelps: 'A Critical Study of the Methods in Current Use for the Determination of Free and Albuminoid Ammonia in Sewage.'

Wm. Royal Stokes: 'A Simple Test for Routine Detection of Colon Bacillus in Drinking Water.'

George A. Johnson: 'Isolation of Bacillus Coli Communis from the Alimentary Tract of Fish and the Significance Thereof.'

Charles Harrington: 'Sodium Sulphite: A Dangerous Food-Preservative.'

Stephen de M. Gage and George O. Adams: 'Studies of Media for the Quantitative Estimation of Bacteria in Water and Sewage.'

Announcement has been made of the initial numbers of a series of *Bulletins* on pathology from the laboratory of the Medical Department of the University of California, Berkeley, under the editorship of Dr. Alonzo E. Taylor, head of the Department of Pathology and director of the Hearst Laboratory in San Francisco.

SOCIETIES AND ACADEMIES.

THE NEW YORK ACADEMY OF SCIENCES.
SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

The regular meeting of the section was held on February 29 at the American Museum of Natural History in conjunction with the American Ethnological Society. The program was as follows:

Ethnological Survey of the Pueblos of New Mexico and Arizona, during the Summer of 1903: Mr. George H. Pepper.

Mr. Pepper first went to Española, and from there visited the pueblos of Santa Clara, San Ildefonso, Pojoaque, Nambe and Tesuque. One of the ceremonial dances at the pueblo of Santa Clara was witnessed. San Juan, Picoris and Tesuque next received attention. After this work was completed the Hopi region was visited, the time selected being the occasion of the Antelope and Snake dances at Walpi. In the pueblos of Hano, Sichomavi and Walpi, special attention was devoted to the work of the Hopi potters, particularly Nampayo of Hano, who is the only one living that has made a careful study of the old pigments and clays.

On the second mesa the pueblos of Mashongnavi and Shungopavi were visited, and the Snake Dance at Mashongnavi observed. Oraibi, the seventh of the Hopi pueblos, situated fifteen miles to the west of the second mesa, came next. During the stay in this pueblo the wonderful Flute ceremony was enacted. From the Hopi region the route taken

led to the pueblo of Laguna in the western part of New Mexico, and from there to Acoma, where the Fiesta de San Esteban was seen. While in the pueblo of Isleta the Fiesta de San Augustine took place.

Visits to the pueblos of Jemez, Zia, Santa Ana, Ranchitas de Santa Ana, Sandia, San Felipe, Santo Domingo, Cochiti and Zuñi completed the season's work, which included all of the twenty-six 'mother pueblos' now inhabited.

The subject of primitive pottery-making as represented in the various groups was carefully considered and the technique of each culture was investigated. Samples of the materials used in the manufacture of pottery were obtained, as well as representative forms of finished vessels from each pottery-making pueblo. Nearly one thousand negatives were made to supplement the field notes, and to enhance the value of the exhaustive card catalogue pertaining to southwestern ceramics, which is now in the course of preparation.

Archeological Survey of the Interior of the State of Washington, during the Summer of 1903: MR. HARLAN I. SMITH.

Archeological explorations of the Jesup North Pacific Expedition were carried on in 1897 by Mr. Smith in the Thompson and Fraser River valleys of Southern British Columbia, and in 1898–99 in the shell-heaps along the coasts of British Columbia and Washington. In continuance of the general archeological reconnoissance thus begun in the northwest, the Columbia Valley was chosen as the field for research during the field season of 1903.

It was thought that by working in the Yakima Valley the boundary between the culture of The Dalles and that of the Thompson River region might be determined. The material, however, discovered by the expedition seems to prove that the Yakima Valley was inhabited by people having a culture which previously had been unknown to science.

In the region were found numerous evidences of the close communication of the people of this culture with tribes of the Thompson River region. Underground house sites, tubular pipes, engraved detalium shells, a decoration consisting of a circle with a dot in it, and rock-slide sepulchres, each of a particular kind, were found to be peculiar to both regions.

A considerable amount of material of the same art as that found in the Dalles region was seen. It is clear that the people living in the Yakima valley had extensive dealings with the tribes both northward, as far as the Thompson valley, and southward, as far as The Dalles of the Columbia. In this connection it is interesting to note that the present Indians of the region travel even more extensively than would be necessary to distribute their artifacts this far. Much less evidence of contact between the prehistoric people of the coast of Washington and that of the Yakima valley was discovered. A pipe, however, was seen which is clearly of the art of the northwest coast. It was found far up the Toppenish River (one of the western tributaries of the Yakima).

From the Yakima Valley the expedition was transferred to the lower Cowlitz River for work down that stream and along the Columbia from Portland to its mouth, partly to determine whether or not a portion of the evidences of coast culture which were found in the Yakima valley had not come up the Cowlitz and down the Toppenish River, since the head waters of the Cowlitz and the Toppenish are near each other. In this region many specimens were secured. The main work, however, was done in the Yakima valley, where many photographs were taken, not only of archeological sites, but also of the country in general. Human remains, which are useful in determining the type of these old people, were also collected.

The most remarkable specimen secured was a piece of antler carved in human form. This was very thin, and when found it was nearly as soft as so much sawdust or moulder's sand pressed together tightly. Proper treatment has rendered the object quite hard and able to bear handling. It was found under the vertebræ of a child in a grave. The grave was of peculiar interest because, contrary to usual practice, the body had been enclosed in a rude box made by placing about it thin slabs of

stone, and the cist thus formed had been covered with jagged fragments of rock, over which earth was spread. This doll-like carving of antler is considered to be one of the finest pieces of prehistoric art ever found in northwestern America.

James E. Lough,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

The Section of Geology and Mineralogy held its regular meeting January 18, 1904, with the chairman, Professor James F. Kemp, presiding. In the absence of the secretary, Dr. A. A. Julien was appointed secretary *pro tem,* and papers by Dr. Irving and Mr. Wilson, abstracts of which follow, were presented.

Microscopic Structure and Origin of Certain Stylolitic Structures in Limestone: J. D. Irving.

From an extended examination of stylolitic limestones collected in Indiana and Wyoming, mainly by Mr. M. L. Fuller and himself, the author has drawn the following conclusions regarding the origin of the peculiar structures:

1. They were initiated along a thin clay layer in limestone and have been produced by the interpenetration of the limestone material on either side of this clay seam.

2. They are entirely independent of the presence of fossils existing in the rock, for they occur equally in those portions of the rock where fossils are absent and where they are present.

3. They were not formed by metamorphic agencies, or by the weight of overlying strata, or by other causes which would tend to distort and crush the rock material.

4. They were produced by a cause which operated on the material of the rock while it was yet unconsolidated, and in a condition approximating that which obtained at the time of deposition.

5. They originated under great pressure, the rock material being sufficiently soft to allow the bending of individual stylolites, and yet potentially rigid, so that organisms were sharply sheared off while held in the soft matrix.

While the cause of the pressure and the manner in which it had operated to produce these structures has not been determined, the author suggests that their production may be the result of the hydrostatic pressure of the sea water lying above the deposits. In the instances examined stylolites are characteristic of marine deposits formed in water varying from 400 to 2,500 fathoms in depth. If sea water be taken to have an average specific gravity of 1.028, then a one-foot column of water exerts a hydraulic pressure of .434 lb. per sq. in. of area. This would give, for the depth stated, a hydrostatic pressure of from 1,041 to 6,408 lbs. per sq. in. Such a pressure as this, coupled with the soft unconsolidated nature of the rock at the time it might have been exerted, seems to fulfil better than any other the conditions demanded by the observed facts.

Recent Journeys among Localities Noted for the Discovery of Remains of Prehistoric Man: J. Howard Wilson.

The author discussed man in the earliest times before the Neolithic age and afterwards illustrated his paper by nearly forty views of some of the most famous rock shelters, caves and deposits of Europe which have furnished remains of paleolithic man, including also slides of the type implements and weapons from which have been derived the principal evidence of man's existence in Quaternary times.

The paper recited briefly the history of the subject, the first finds, especially the work of Boucher de Perthes, and the gradual development of the science of prehistoric archeology. Reference was made to some of the disputed evidence of man's existence in the Tertiary period, and then the subject of man's existence as early as the Second Glacial period was treated more at length, with a consideration of the climate and physical conditions which prevailed in paleolithic times.

The paper closed with an attempt at a realization of the great antiquity of paleolithic man as shown by the immense physical and geological changes which have taken place since he first made his undoubted appearance.

At the regular meeting, February 15, Vice-President James F. Kemp presiding, the secretary read a letter from Dr. J. G. Aguilera correcting a statement in one of the papers presented at the December meeting of the academy, as reported in SCIENCE, regarding the great Bacubirito meteorite of Mexico. Dr. Aguilera called attention to the fact that this meteorite was discovered in July, 1871, as was stated by A. del Castillo in 'Catalogue descriptif des Meteorites,' Paris, 1889. It was described by F. Sosa y Avila in *Minero Mexicano* in 1890, and afterward was visited by Signor Buelna as a commissioner of the Geological Institute of Mexico for the purpose of calculating the cost of transporting it to the City of Mexico. In connection with this expedition Buelna made several drawings and photographs of the great mass of iron. Through the Geological Institute Professor H. A. Ward received exact information as to the locality of the meteorite and then visited it, removing the earth from about it and making new photographs. Professor Ward's recent articles (1903) have drawn renewed attention to this enormous meteoric mass, but the credit of original discovery and description belongs to the Mexicans.

The program of the evening comprised two papers, abstracts of which follow:

The Occlusion of Igneous Rock within Metamorphic Schists: DR. ALEXIS A. JULIEN.

The term 'inclusive' is commonly applied, by the petrographer, to ordinary dikes of igneous rock, surrounded by beds of sedimentary rocks or of crystalline schists, intersecting them or intervening between their foliation planes. But for similar masses cut loose from all connection with the underlying magmatic source, swallowed up within strata of crystalline schists, and experiencing all stages in the process of reaction and final absorption, during metamorphic change, another term seems to be called for, 'occlusion,' signifying shut or sealed up beyond escape. Although the word is borrowed from the physicist, this can produce no confusion when applied to petrographic phenomena. Occluded igneous rocks may belong to either the acid or the basic class, as illustrated respectively, on Manhattan Island, by the earlier intrusions of pegmatite, never found as intersecting dikes, and by the intercalated sheets of diorite-schist. Occlusion is usually attended by mechanical and chemical processes. The former consist of thinning or thickening of igneous masses caught between the folia of schists during orogenic movements into lenticular masses; the crumpling and corrugation of sheets, and even rolling into cylinders; and the forcing of the pasty masses along foliation planes, in the form of intercalated or 'secondary' dikes. The chemical processes usually consist of micaceous alteration and ultimate absorption by disintegration and dissemination through the surrounding country rock.

In discussing this paper, Professor Kemp spoke of the value of the interpretation to those who have studied the region.

Outlines of the Continents in Tertiary Times: DR. W. D. MATTHEW.

The author presented a series of world-maps showing the hypothetical outlines of the continents during the Pleistocene, Pliocene, Miocene, Oligocene, later Eocene and at the opening of the Tertiary period, as contrasted with the modern conditions. The series was got up for use in the Hall of Fossil Mammals in the American Museum of Natural History, to illustrate the geographical distribution of different groups of mammals during the successive epochs of the Tertiary and Quaternary. It is intended to represent a somewhat conservative view of past changes in world geography, and is regarded as a working hypothesis, based on our present knowledge of geology, paleontology and zoology, especial consideration being given to the mammalian paleontology.

The former extension of the Antarctic continent, so as to join Australia with South America, is regarded as occurring at the end of the Cretaceous period and is represented in the first map of the series. The connection with South Africa is regarded as too problematic to place on the map. The Eocene map shows the extreme of Tertiary submergence of the continents which are represented as forming six isolated land masses. The

three northern continents are connected throughout the Oligocene, Miocene, Pliocene and Pleistocene, Africa being joined to them by the Miocene, South America by the Pliocene epoch. The Pleistocene map shows especially the simultaneous glaciation of both northern and southern regions, modified in the north by sinking of the old Arctic continent beneath the sea level.

The supposed ancient continents of Lemuria, Atlantis, the Brazil-African land bridge, etc., are regarded either as proposed on insufficient data or as being outside the limits of this series.

In general it has been found possible to consider the true ocean basins (limited by the 1,000-foot contour) as permanent throughout Tertiary time. The union of Antarctica with Australia and South America is an exception to this rule, but is based on a large amount of evidence. It appears probable also that the disturbed belt which stretches through central Europe to south-central Asia, and ends perhaps in the East Indian islands, has been, in part, raised from abyssal depths to an equally stupendous height above the sea, since the beginning of the Tertiary.

Discussion.—Professor Osborn emphasized the value of these maps as expressing working hypotheses for the use of students of vertebrate paleontology.

Dr. Julien called attention to the evidences of glaciation in South Africa as having a bearing upon the question of a previous existence of land masses farther south.

Edmund Otis Hovey,
Secretary.

ASTRONOMY, PHYSICS AND CHEMISTRY.

The regular meeting of the section was held on February 1 at the American Museum of Natural History.

The first paper of the evening was a biographical sketch of the late Dr. H. Carrington Bolton by Dr. D. S. Martin, which was read by Professor Crampton, the recording secretary of the academy, in the absence of Dr. Martin. The section then passed a resolution to the effect that Dr. Martin's address should be published in the *Annals* of the academy, together with a bibliography of Dr. Bolton's papers.

The second paper was entitled 'Researches as to the Identity of Lexell's Lost Comet of 1770 with the Periodic Comet of 1889, 1896 and 1903,' and was read by Professor Charles Lane Poor. This paper gave the result of a new investigation of the motion of the periodic comet of 1889, 1896 and 1903 (Brooks), dealing especially with the great changes in its orbit caused by the close approach to Jupiter in 1886. The comet has now been seen at three returns to perihelion and the many observations made allow of a most accurate determination of the present orbit on which to base the investigation. Attention was called to the supposed identity of this body with the lost comet of Lexell, 1770, which disappeared after passing close to Jupiter in 1779, and this question was discussed at length.

The next paper, entitled 'The Year's Work with Radium,' was read by Dr. George B. Pegram, and was the second of the series on 'Recent Progress in Physical Science.' Dr. Pegram gave a review of the most important experimental and theoretical advances made during the past year in the knowledge of radio-activity; especially the work of Rutherford and Soddy in formulating the atomic disintegration theory of radio-active change, the discovery of Curie in regard to the heating effect of radium, and the experiments of Ramsay and Soddy bearing on the question of the continuous production of helium in radium compounds. An apparatus was exhibited like that of Mr. Strutt, to show by the alternate charging and discharging of an electroscope the production of electric charges by radium. The charging of the gold leaf in the apparatus shown by Dr. Pegram took place in about one minute.

The next meeting of the Section of Astronomy, Physics and Chemistry was held on March 7 and was devoted to an address by Dr. S. A. Mitchell under the title 'Recent Progress in Astronomy,' the subject being 'The Results of the Observations of the Last Solar Eclipse.' Dr. Mitchell gave an interesting *résumé* of the results obtained by the

different expeditions which made observations in the island of Sumatra on May 18, 1901.

CHARLES C. TROWBRIDGE,
Secretary.

THE CHEMICAL SOCIETY OF WASHINGTON.

THE 149th regular meeting of the Washington Chemical Society was held on Thursday, March 10, at 8 P.M., in the Assembly Hall of the Cosmos Club.

The regular program for the evening was preceded by appropriate remarks and the presentation of resolutions (published on page 595 of this journal) upon the deaths of Mr. E. E. Ewell and Dr. E. A. de Schweinitz, both of whom were former officers of the Washington Chemical Society.

The first paper on the program, entitled 'Testing and Quality of Chemical Reagents,' was presented by Mr. Lyman F. Kebler.

The speaker first considered the subject from the point of view of the manufacturer who, on account of competition and the demands for lower priced material, often finds it necessary to send out inferior reagents designated as 'C. P.' with the tacit understanding that this abbreviation stands for something other than its generally accepted meaning. The speaker believed that the above condition of affairs could eventually be overcome by the establishment of standards of purity for all chemical reagents, and the agreement of chemists and consumers generally to insist upon receiving goods which are of the purity designated. Such a plan would tend to put all manufacturers on an equal footing and make it impossible for one firm to sell a lower grade of goods for the same price that another receives for better reagents.

A great deal of the trouble up to the present time was considered to be due to the fact that government chemists generally have not insisted on getting pure materials, and it has, therefore, been difficult for chemists connected with manufacturing establishments to maintain a high degree of purity, because it is frequently contended by dealers, that what is accepted by the government ought to be good enough for the individual. The speaker urged the necessity for all chemists standing together in the matter. A large number of specimens of reagents containing a greater or less amount of impurity were exhibited, and discussion on the subject was entered into by Messrs. Hillebrand, Voorhees, Tolman and Noyes.

The second paper on the program was presented by Mr. B. J. Howard, and was entitled 'Comparison of Tests for Turmeric in Mustard.'

Turmeric may be added to mustard either in the powdered or else as a form of extract. Though added as a powder, if it is subsequently made up into prepared mustard by heating with water or vinegar, or both, the condition for the purpose of analysis is the same as the case of an extract.

Five methods of testing were made, viz., (1) the alkali test, (2) the sulphuric acid test, (3) the diphenylamine test, (4) the boric-hydrochloric acid and (5) the boric-oxalic acid test. The last two are merely adaptations of the tests made use of for detecting borax or boric acid used in foods as preservatives. The boric-hydrochloric acid reagent is made up of about equal parts of a saturated aqueous solution of boric acid and an equal solution of strong hydrochloric acid.

For the detection of turmeric in the powdered form a thin film of the sample to be tested is spread upon a microscope slide with a few drops of the reagent and examined with a low power lens or reading glass. When the boric-hydrochloric acid is used the film is allowed to evaporate—the best results being obtained with spontaneous evaporation. With sulphuric acid, boric-hydrochloric acid, or diphenylamine one part of powdered turmeric to 20,000 of mustard is easily detected, and much more positively than with either of the other reagents. In using diphenylamine, however, care must be taken not to confuse the after color produced by the action of the reagent upon the mustard itself for that produced by the turmeric.

For the detection of turmeric in the extract form the method must be modified. The sample is mixed with three or four times its volume of 90 per cent. alcohol, and allowed

to stand for one or more hours, shaking from time to time. The solid particles are then allowed to settle and a portion of the supernatant liquid poured into a salt cellar. A wedge-shaped strip of filter paper is suspended so that the tip dips a short distance beneath the surface of the liquid. The liquid is drawn up into the paper, and as evaporation takes place the turmeric is concentrated in the filter paper for subsequent testing. After standing for a few hours the paper is tested by the boric-hydrochloric acid reagent upon a porcelain or glass plate. A pink or bright red color which turns blue when treated with ammonia indicates the presence of turmeric. Some anilin dyes used for coloring mustard give a similar red tint but are not turned blue with ammonia. If a few drops of the boric-hydrochloric acid are added to the test liquor in the salt cellar before absorbing into the filter paper, the pink color shows up as the drying proceeds and thus sometimes lessens the time required in making the test.

The third paper on the program was presented by Mr. E. McKay Chace, and was entitled 'The Use of Basic Aluminium Acetate as a Preservative in Sausage.' Two samples of imported sausage were found to be preserved with aluminium salt to the extent of 200 milligrams to the pound can. The manufacturer of one of the samples admitted having used basic aluminium acetate in the proportion of one half of one per cent.

As aluminium does not occur in the animal organism a qualitative test is sufficient to detect its addition. The following test was used: Ash the sample, boil with strong HCl, add NaOH in excess, filter, make the filtrate acid and precipitate the aluminium with ammonia. The aluminium hydroxide and phosphate may be filtered off and tested on charcoal with cobalt nitrate.

For a quantitative determination the method of Wachenroder and Fresenius was used. (Fresenius, 'Quantitative Analysis,' 1904, Vol. 1, p. 459.)

It was found that aluminium formed a stable compound with the constituents of the sausage, which was insoluble in water, or HCl $N/10$ strength, but which was broken up on digestion with pepsin in .33 per cent. HCl, showing that the aluminium would be set free to retard the digestion in the stomach and intestines.

A. Seidell,
Secretary.

THE ONONDAGA ACADEMY OF SCIENCE.

At the January meeting of the Onondaga Academy of Science held in Syracuse, N. Y., the following officers were elected:

President—E. H. Kraus.
Vice-President—P. F. Schneider.
Recording Secretary—Albert M. Reese.
Corresponding Secretary—J. E. Kirkwood.
Treasurer—Miss L. W. Roberts.
Librarian—Mrs. L. L. Goodrich.
Councilors to serve until 1907—Mr. J. D. Wilson and Mrs. M. B. Ackerman.

The annual reports of the different sections follow:

Zoology.—Professor C. W. Hargitt. The section of zoology suffered an irreparable loss in the death of its chairman, Mr. H. W. Britcher, which occurred early in the year.

As a field naturalist he had few equals either among his associates in the academy or throughout the state. This will be measurably attested in the admirable check-list of the spiders of the county, which appears in the recent volume of the *Proceedings* and constitutes his final contribution to science, passing into type almost coincidently with the passing of his life. Other observations of like character are recorded in earlier contributions; notes on amphibia, reptilia and mammalia of the county appearing in the same volume. Would that his mantle might fall upon some worthy successor!

Botany.—L. Leonora Goodrich. The botanical class organized by certain members of the section has pursued a study of trees in winter which has proved very interesting. Of special interest, however, is the discovery of three plants new to this (Onondaga) county, one of which is new to the state. *Gaura biennis* was found among the limestone rocks near Belle Isle, and *Lythrum Salicaria* between Syracuse and Baldwinsville, about six miles from the city. In October *Phacelia dubia* was found growing on top of limestone rocks about eight miles south of Syracuse.

In this locality the plant was abundant and in bloom, notwithstanding the fact that its usual time of flowering is from April to June. This appears to be the farthest northern limit of this plant's occurrence and the only station thus far reported for it in this state.

Geology.—P. F. Schneider. The discovery is noted of two overthrust faults of small throw in the limestones of the Waterlime group, exposed by a cutting on the Jamesville suburban road. They are especially interesting because of the rarity of such occurrences in our horizontally stratified Paleozoic rock.

Several marked disturbances were also discovered in the limestones of the Helderberg series along the route of the Marcellus line and studied. A cave of considerable size was also opened up by the line of the Auburn interurban road.

Peculiar crystals of bright sparkling hematite have been found in the Red Shale of the Saline formation, especially in the lines of the cavities formed by the pseudomorphs after salt. These have been collected, described and studied. Crystals of celestite have also been discovered disseminated through one or more of the layers of the waterlime group in a recent railroad cutting near Jamesville. Some of the cavities are over half an inch in length and show the fauna of the celestite crystals perfectly preserved. More of the peculiarly clear and limpid quartz crystals have been found in the veins of the crystalline Onondaga limestone and described. Much additional information has also been added to our knowledge of local Pleistocene geology.

J. E. KIRKWOOD,
Corresponding Secretary.

THE ACADEMY OF SCIENCE AND ART OF PITTSBURG. SECTION OF BIOLOGY.

THE monthly meeting of this section of the academy was held in the lecture hall of the Carnegie Institute, on January 5. Professor John C. Fettermann, biologist of the Western University of Pennsylvania, lectured on the 'Relation of Bacteria to the Dairying Industry.'

The lecturer brought out a number of facts concerning this very important industry. He discussed the nature of milk as it is secreted from the milk glands; the various bacteria commonly found in milk, and sources of contamination; the keeping qualities of milk, and the influence temperature has on the development of the bacteria; the different preservatives used to keep milk from souring, and their action on milk, and the injurious effect upon the consumer. Condition of milk as sold in large cities; the significance of the great numbers of bacteria present in normal milk; results of the bacteriological examination of normal milk, and the facts regarding sterilization and pasteurization; the use of pure cultures in butter making; the prevalence of particular bacteria in certain localities, by which means a peculiarly desirable flavor is imparted to the butter; the introduction of these bacteria into other localities, in order to produce butter of an equally good quality; the occurrence of bacteria in cheese, and their importance to the manufacturer.

A number of cultures in culture tubes were exhibited, showing the various stages of the development of the bacteria, and their effect on the milk. The method of making the cultures was also explained. The discussion following the lecture chiefly concerned tuberculosis and the danger of inoculation of human subjects by the use of milk coming from infected cattle.

Professor Fettermann stated that, unless the tuberculous stage involves the udder of the cow, there need be no cause for apprehension of inoculation of human subjects, and as this only occurs in about one per cent. of all cows infected with tuberculosis, the danger resulting from the use of such milk is insignificant.

Professor J. B. Hatcher exhibited before the section a molar tooth of *Mastodon* (*Tetralophodon*) brought from Burmah by Mr. J. F. Weller, of Emlenton, Pa. The specimen, which belongs to *M. latidens* or a closely related species, exhibits an interesting stage in the passage of the molar teeth of the Proboscidea from the conular type of the mastodons to that of the elephants, where the

enamel is arranged in numerous transverse laminæ.

Frederic S. Webster,
Secretary-Treasurer.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY GEOLOGICAL JOURNAL CLUB.

The club has reviewed the following papers during the month of February:

W. G. Ball, 'The Outlook for Mining in the New Territory Opened up by the San Pedro, Los Angeles and Salt Lake Railroad' (*Eng. and Min. Jour.,* February 4, 1904); G. G. Wald, 'Comparison of Fatal Mining Accidents in the United States and Great Britain' (*Eng. and Min. Jour.,* January 14, 1904); L. T. Buell, J. T. Glidden, W. L. Spalding and E. Burton, 'Theories of Ore Deposition Historically Considered' (*Eng. and Min. Jour.,* December 14, 1903); G. F. Loughlin, 'The Differentiation of Rock Magmas' (*Eng. and Min. Jour,* October 17, November 28 and December 14, 1903). These papers were discussions by J. F. Kemp and Blamey Stevens, and the arguments were presented by Mr. Loughlin, with illustrations of occurrences of igneous rock in Massachusetts. R. H. Allen, 'The Production of the Minor Minerals in 1903' (*Eng and Min. Jour.,* January 14 and 21, 1904); J. Daniels, 'The Geology of the Kolas Gold Fields' (*Eng. and Min. Jour.,* February 11, 1904); B. L. Johnson, 'Native Gold Original in some Metamorphic Gneisses' (*Eng. and Min. Jour.,* February 4, 1904); S. Shapira, 'Mining in Korea' (*Eng. and Min. Jour.,* March 3, 1904); U. S. Whittemore, 'The Origin, Properties and Uses of Shale' (*The Michigan Miner,* November, 1899, to February, 1900).

The following original papers were presented:

H. W. Shimer, 'The Discussions of Questions Arising from the Interpretation of Faunas with Reference to Trilobite Mountain, Orange Co., N. Y. 'The paper was taken from the results of detailed study in the region, and dealt mainly with the determining of strata in the absence of definite fossil evidence. The complete results are now in process of publication. G. Richards, 'Experiences in Mining in Mexico.' Dr. C. H. Warren, 'Asbestus as a Fire-Proofing Material.' Experiments by Dr. Warren on chrysolite, the principal asbestus of commerce, showed that it lost its cohesive strength after being subjected to red heat from three to four minutes, and gave ground for the conclusion that, in cases of great fires, asbestus could, at the most, serve only to delay the progress of the flames for a few minutes.

G. F. Loughlin,
Secretary.

THE CLEMSON COLLEGE SCIENCE CLUB.

The club held its regular monthly meeting on Friday night, January 15, 1904.

Professor W. M. Riggs gave some facts and figures in regard to street railways, as compiled from reports of the last census. The figures were especially interesting as showing the small number of fatalities resulting from travel on street cars.

Professor H. Benton gave a communication entitled 'The Shipment of Fruits and Vegetables on a Commercial Scale.' The speaker explained in detail the different kinds of shipping cases used in practice and pointed out the defects and advantages of the different types. The methods used in packing and handling the various fruits and vegetables on some large gardens and orchards in Georgia were pointed out. The methods of packing the various fruits and vegetables were explained, special attention being paid to the cantaloupe. The construction and method of filling refrigerator cars were explained and the defects in the method of refrigeration, as used at present, were pointed out. Some of the improvements which have been proposed, namely, refrigeration by means of liquid air, etc., were mentioned. The effect of cold storage on fruit was shown by means of lantern slides. The whole paper was illustrated by a number of lantern slides.

Under the title of 'Some Leaf Mining Insects,' Professor Chas. E. Chambliss gave notes on *Bucculatrix pomifoliella, Aspidisca splendoriferella* and *Tischeria malifoliella.* The work and the stages in the development

of *Tischeria malifoliella* were illustrated by photographs and photomicrographs.

F. S. SHIVER,
Secretary.

CLEMSON COLLEGE, S. C.,
March, 1904.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

THE academy held a regular meeting on March 7, Mr. Edwin Harrison presiding.

Dr. C. A. Snodgrass, city bacteriologist and pathologist, read a paper on the subject 'Bacteria and Their Work,' illustrated with drawings and cultures. He gave a clear conception of the place occupied by the bacteria in the living world, and the important work they were doing. He emphasized the fact that bacteria must not be confounded with disease. The following were some of the topics discussed: The distribution of bacteria on the globe; nitrogen fixation; changes in bacterial flora in milk supplies; the bacteria of the Illinois, Missouri and Mississippi Rivers; symbiosis; immunity; biological factors that affect bacteria; the relation of human and bovine tuberculosis, and various methods by which infection occurs.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA.

THE 153d meeting was held in the Physics Lecture Room, Tuesday evening, March 8. The following papers were presented:

PROFESSOR A. S. WHEELER: 'Mercerization.'

PROFESSOR I. H. MANNING: 'The Work of the Digestive Glands.'

PROFESSOR CHARLES BASKERVILLE: 'Kunzite, the New Gem; Its Unique Properties' (with demonstrations).

A. S. WHEELER,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

DR. CASTLE AND THE DZIERZON THEORY.

IN a recent number of SCIENCE (March 4, 1904), Dr. W. E. Castle offers some criticism of my paper entitled 'The Origin of Female and Worker Ants from the Eggs of Parthenogenetic Workers,' published in the same journal December 25, 1903. My paper was written for the purpose of calling attention to certain observations which go to show that worker ants can produce worker offspring, probably from unfertilized eggs. I indicated the possible bearings of such observations on current theories of sex, instinct and natural selection. Incidentally, I protested against the wording of the Dzierzon theory in such terms as to preclude further investigation of certain phenomena covered by it, against a premature extension of the theory to groups of social insects less perfectly known than the bees, and against its use in bolstering up other hypotheses.

Castle pleads guilty to having used terms like 'invariably' in formulating the Dzierzon theory, but tries to evade the point by remarking that 'it scarcely requires explicit statement here that *all* conclusions of inductive science must be so qualified,' that is, by using such expressions as 'so far as observed' instead of 'invariably,' 'always,' etc. It is difficult to see what Castle gains by this statement unless he wishes to imply that all the conclusions of inductive science are on the same dead level of probability—Dzierzon's theory, the circulation of the blood, the etiology of cancer, the rotation of the earth and what not.

After virtually admitting that I was justified in objecting to his formulation of the Dzierzon theory, Castle feels called upon to present the arguments in favor of that theory, all of which are well known to every tyro in zoology. The remarks prefacing Castle's disquisition show that he regards the Dzierzon theory as sufficiently and satisfactorily established, and any expression of doubt concerning some of its implications as certainly useless and possibly heretical or even malicious. He desires to 'join issue' with me 'sharply.' Although I am by no means opposed to the Dzierzon theory, I accept the challenge, both because I do not wish to disappoint Castle and because his presentation of my views amounts almost to misrepresentation.

Since its promulgation more than half a century ago, there has never been a time when the Dzierzon theory lacked opponents, both among the bee-keepers and among zoologists

and physiologists. That this is still the case is shown by von Buttel-Reepen's renewed defense of the theory within the past two months, that is, since my paper was published.* Of course, such opposition by no means proves that the theory is false, but it shows very clearly, nevertheless, that the phenomena to be explained must be extremely complicated and difficult of observation. And no one who has studied bees or other social insects can doubt the truth of this statement for a moment. Our knowledge of many of the honey-bee's habits, so unique among animals, is based on inferences often very remote and derived from conditions difficult to control; and hence, from a strictly scientific standpoint, more or less insecure. It is impossible to observe these or any other social insects without a sense of powerlessness to ascertain just what is taking place in the life of the colony. We see the insects feeding and rearing their broods and regulating the number and character of the personnel of their colonies with a sure instinct analogous to the regenerative and regulatory phenomena manifested by the tissues of the individual organism, but all this takes place as if it were behind a veil. When we are still so profoundly ignorant of the exact way in which these wonderful creatures bring about the differences between the queen and the worker, that is, between two forms of the same sex, is it at all likely that we can pose as knowing how the sexes themselves are differentiated? And even if we accept the Dzierzon theory for the bees, are we justified in transferring it to other insects of which our knowledge is still less satisfactory? Even so confirmed an advocate of the Dzierzon theory as von Buttel-Reepen regards such an extension as inadmissible at the present time.†

Leuckart long ago stated that complete proof of the Dzierzon theory would be forthcoming only when we should have an accurate knowledge of the bee's egg. There are some, like Castle and von Buttel-Reepen, who believe that this knowledge has been supplied by the recent Freiburg researches carried out by Petrunkewitsch.* Knowing from experience the extreme difficulty of interpretation and the possibilities of error involved in a study of the polar bodies of the insect egg, I venture to dissent from this view and to regard the knowledge to which Leuckart referred as still in the lap of the gods. In support of this statement, I may briefly discuss one aspect of Petrunkewitsch's work, his contention that the reproductive organs of the drone develop from the second polar body of the egg. This fantastical conception, for which not a particle of evidence had ever been furnished by any animal, was suggested as a laboratory hypothesis by Weismann 'mit aller Reserve' to Petrunkewitsch while the latter was still working on his dissertation. The suggestion bore fruit in the 'Habilitationsschrift' as a truly miraculous example of Weismann's powers of prophesy. But to any one who is at all familiar with the developmental stages under discussion, Petrunkewitsch's figures suggest anything but what he attempts to prove. Even in his first paper there is no satisfactory evidence to show that the cells regarded as derivatives of the polar bodies in the figures on plate 4 are really such, and not dividing cleavage cells or possibly vitellophags. These stages are all separated by a great gap from those represented on plate 3. When we take up the second paper we wonder how anybody could regard the figures there presented as even an adumbration of proof that the testes of the drone are developed from the polar bodies. There is, in fact, every reason to suppose that what Petrunkewitsch calls 'Zellen, aus dem Richtungscopulationskern entstanden' in his Figs. 1, 2 and 3, are vitellophags with altered nuclei, such as are often seen in

* 'Entstehen die Drohnen aus befruchteten Eiern?' *Bienenwirthschaft. Centralbl.*, No. 3, ff., 1904, 28 pp.

† 'Die stammesgeschichtliche Entstehung des Bienenstaates,' etc., Leipzig, Georg Thieme, 1903, pp. xii, 1–138, 20 figs.

* 'Die Richtungskörper und ihr Schicksal im befruchteten und unbefruchteten Bienenei,' Inauguraldissertation, *Zool. Jahrb. Abth. f. Anat. u. Ont.*, 14. Bd., 4. Heft, 1901; 'Das Schicksal der Richtungskörper im Drohnenei.' Habilitationsschrift., *Zool. Jahrb. Abth. f. Anat. u. Ont.*, 17. Bd., 3. Heft, 1902.

the yolk of fertilized insect eggs (*Doryphora, e. g.*) coexisting with healthier vitellophags provided with more rotund nuclei. When we come to the polar body derivatives in his Figs. 3, 5, 6, 7 and 8, we recognize the well-known 'dorsal organ,' or remains of the serosa aggregating and preparing to pass into the yolk. Between these stages and that of his Fig. 10 with nearly completed mesenteron (which he derives from the mesoderm [*sic!*]) there is another big gap, and so far as the figures go, no demonstrable connection to show that the testes are really derived from such an absurdly improbable source as the 'dorsal organ,' to say nothing of the polar bodies. The only figures in Petrunkewitsch's paper showing unquestionable rudiments of the reproductive organs are Figs. 14, 15, 17, 18, 19 and 20, and in all of these the organs are depicted in the relatively late stages of development that have been figured repeatedly by other authors. Then note the startling migrations described for the drone's testes and their antecedent cells! The second polar body is at first on the anterior cephalic surface of the egg. The cell derivatives leave this surface and divide into two groups which migrate to the dorsocephalic region and there reunite. The mass thus formed then proceeds caudally along the mid-dorsal line just beneath the blastoderm till it enters the abdominal region, where it breaks up into cells, which migrate ventrally on either side as far as the mesoblastic somites, become entangled with these and are again carried dorsally to the position of the definitive testes. Was ever organ more bedeviled in its development? And what shall we say of the 'critical caution' not only of taking work of this kind seriously, but of using it for propping up at one of its weakest points a complicated theory of sex?* And if such work on the origin of the drone's testes can be made the basis of a 'Habilitationsschrift,' how implicit should be our faith in the same author's 'Inauguraldissertation'?

Having, as he supposes, established the Dzierzon theory beyond cavil, so far as it deals with the honey-bee, Castle next proceeds to consider the ants, after the fashion of the typical laboratory zoologist whose motto is 'all species look alike to me.' He finds it necessary to admonish me for deeming it 'even a probability' that workers may develop from the unfertilized eggs of workers. Had he taken the pains to read the observations of Reichenbach and Mrs. Comstock with care, or better still, had he acquired a first-hand acquaintance with the two insects mentioned by those authors, namely *Anergates atratulus* and *Lasius niger,* he would have seen that his criticism is really as feeble as it is captious. A more careful writer would have observed that Reichenbach is not a myrmecologist and that his remarks on *Anergates,* etc., were cited mainly on account of their psychological interest as showing the flurry into which a man is thrown on discovering a fact that conflicts with some formidable theory. *Anergates atratulus* is a rare, monotypic, parasitic ant, which has lost its worker caste and has wingless, pupa-like males. Obviously, in such a species there can be no nuptial flight, and mating would naturally take place in the nest. Since the worker caste is non-existent, Reichenbach's, and hence also Castle's, reference to this species, is really irrelevant. In regard to *Lasius niger* Castle asks: "Is there any reason for supposing that the ants captured [by Mrs. Comstock] had not previously been with males? * * * May we not reasonably exercise some 'critical caution' before with Wheeler we conclude it probable 'that worker ants can really produce other workers or even queens parthenogenetically'?" It is

* I allude to that salmagundi (*Bull. Mus. Comp. Zool.*, Vol. XL., No. 4) in which the *disjecta membra* of certain Darwinian, Weismannian and Mendelian theories concerning three such intricate subjects as heredity, sex and parthenogenesis, are stirred to the point of turbidity, garnished with a few accessory hypotheses, and served up in a pamphlet of thirty pages. As if such messes could be either palatable or digestible! Morgan has presented an excellent criticism of this theory ('Recent Theories in Regard to the Determination of Sex,' *Pop. Sci. Month.*, December, 1903). It turns out to be merely another case of the old fallacy of juggling the phenomenon to be explained—in this case, sex—back into the germ-cells and then pulling it out again *à la* Little Jack Horner, with the naïve assurance of having contributed something 'new' to science.

clear, in the first place, that Castle is himself not only lacking in 'critical caution,' but in consistency, when he asks such questions. Since he accepts the Dzierzon theory and proceeds to extend it to ants, he has no right to change the theory during the transfer. All adherents of this theory would agree in pronouncing fertilization of worker bees by drones an impossibility. They would contend that this had never been seen. Hence if the Dzierzon theory is to be extended to ants we should consistently make the same assumption. Nor would this be merely an assumption. All observations—in this case far more easily controlled than in the bees—go to show that worker ants do not mate with males. The case for *Lasius niger* is even stronger than in the bees on other grounds also. In this ant the differences in size and structure, both in the reproductive organs and in the soma, are vastly greater between the female and worker than they are between the queen and worker bee. No one, to my knowledge, has ever seen even a receptaculum seminis in a worker *Lasius*, though a very distinct vestige of this structure is present in the worker bee.* But even if the receptaculum were present, there is no reason to suppose that it would function any more than it does in the worker bee. This would have to be admitted, however, if we are to interpret Reichenbach's and Mrs. Comstock's observations in accordance with Castle's preconceived notions, for it is clear that in the case of the Reichenbach colony months must have elapsed between the death of the males each year and the laying of the eggs, and Mrs. Comstock mentions the rearing of 'at least three complete broods' of workers in the absence of males. From what we know of other ants we could hardly suppose a *Lasius* worker to function as Castle imagines possible unless it were either a true or an ergatoid queen. But no one has ever seen an ergatoid female *Lasius niger* though this insect is not only the most abundant of ants but the most abundant of animals over a large portion of Europe and North America. In this country it occurs in innumerable colonies from an altitude of 10,000 feet in the Rocky Mountains to the sands of the Atlantic seashore. I have myself collected and examined thousands of these ants without ever seeing anything that even approached an ergatoid female. Is it probable then that two lots of ants collected at random, like those of Reichenbach and Mrs. Comstock, should both contain fertilized ergatoid females indistinguishable externally from normal workers, especially when we consider the remarkable propensity of the workers of this and many other Formicidæ for laying unfertilized eggs? Which, then, is the more probable interpretation of Reichenbach's and Mrs. Comstock's observations? Assuredly that which I advanced in my former paper.

Since the publication of my paper Professor Forel has sent me a short article,* from which I take the following paragraph:

> Zur Erklärung des Polymorphismus der Ameisen hat man zunächst die Analogie der Bienen herbeigezogen, welche im Stande sind, in den ersten Larvaltagen, durch veränderte Ernährung und Vergrösserung der Zelle eine Arbeiterlarve in eine Weibchenlarve umzuwandeln. Ferner hat man nach Siebold stets angenommen, dass die Männchen aus unbefruchteten Eiern, die Weibchen und Arbeiter dagegen aus befruchteten Eiern stammen. Letzere Thatsache schien auch bei den Ameisen zu stimmen, indem ich selbst and dann auch Andere stets Männchen aus unbefruchteten Arbeitereiern erzogen hatten. *Doch haben die neuesten Untersuchungen Reichenbach's klipp und klar den Nachweis geliefert,*

* Castle's familiarity with the conditions in the bee is well illustrated by his remark that 'dissections of egg-laying workers, which were made by Leuckart, revealed no seminal receptacle, hence the eggs of such animals can not have been fertilized.' The existence in worker bees both of a vestigial receptaculum and of accessory glands was pointed out by von Siebold more than sixty years ago. Moreover, Leuckart, as he later admitted, overlooked the receptacle in the dissections alluded to by Castle. A glance at the well-known Leuckart and Nitsche chart of the honey-bee, which can hardly be lacking in the Harvard laboratory, would have shown Castle a by no means insignificant receptacle in both the sterile and the egg-laying worker.

* Ueber Polymorphismus und Variation bei den Ameisen,' *Zool. Jahrb. Suppl.* (*Weismann's Festschrift*), VII., 1904.

*dass aus unbefruchteten Arbeitereiern von Lasius niger Fabr. wiederum Arbeiter entstehen. Also wieder ein Dogma verfrühter Verallgemeinerung, dass in Nichts zerfliesst!**

Surely I may be permitted to express as a probability what the most eminent myrmecologist states in such emphatic language. That I was well aware of the remote possibilities mentioned by Castle, and of others which he does not seem to have surmised, is clear from my express statement that the observations of Tanner, Reichenbach and Mrs. Comstock are 'by no means final.' It would have been natural for a less captious critic to suppose that the views advanced in my paper were not determined solely by the observations cited from other authors, but to some extent by my own experiences, which though less tangible and less readily formulated at the present time, are not less suggestive to me of the trend of future investigation.

Academic convictions like those advanced by Castle can be of service only in prejudging a field of inquiry; they can be of no imaginable use in stimulating or furthering research except indirectly through the spirit of contradiction aroused by their dogmatic character. If Castle had any new facts, or original interpretations of old facts, for that matter, to bring to bear on the problems under discussion, I should be the first to welcome them. We need something more, however, than mere discussions of possibility and probability, if we are ever to dispel the mystery that envelops many of the instincts and reproductive processes in the social hymenoptera.

WILLIAM MORTON WHEELER.
AMERICAN MUSEUM OF NATURAL HISTORY,
March 24, 1904.

* The italics are mine.

VEGETABLE BALLS.

TO THE EDITOR OF SCIENCE: Can any of your readers refer me to any published mention or description (other than in Thoreau's 'Walden') of those balls of matted vegetable matter formed on the sandy bottoms of shallow ponds, apparently under the action of wave-motion? In what ponds or lakes (other than Flint's or Sandy Pond, in Lincoln, Mass.) are they known to occur? Have they any recognized names? Of what materials are they mainly composed other than *Eriocaulon* leaves? Any information will be very welcome.

W. F. GANONG.
NORTHAMPTON, MASS.

SPECIAL ARTICLES.

RIGHT-EYEDNESS AND LEFT-EYEDNESS.

I WISH to solicit the aid of the readers of SCIENCE in securing answers to the following questions concerning left-handed persons they may know:

1. Name, or at least initials, residence, sex, age and occupation?
2. Is the left-handedness complete or only for some of the acts usually performed with the right hand by right-handed persons?
3. Is the left-handedness the result of accident to the right hand or arm, or did it exist from infancy?
4. With which eye is a gun sighted, a board or yard-stick proved straight, or a table level, etc.?
5. With which eye, without glasses, is the vision of letters across a room in a good light the clearest? (Alternate covering either eye, not closing it.)
6. If glasses are worn for distant vision, the oculist's prescription, and the relative sharpness of vision of each eye with the glasses?

Right-handed persons are, I believe, naturally right-eyed, and the left-handed are left-eyed. There is little doubt as to the first, but I have found it difficult to get data concerning a sufficient number of the left-handed.

The fact of right-eyedness or left-eyedness has, it seems to me, much greater significance than the similar conditions pertaining to the hands, but, so far as I can learn, nobody has even thought of it, much less discussed its many suggestive implications. Indeed, I question if the right-handedness or left-handedness is not a simple result of the ocular one-sidedness which preexisted and made necessary the paramount use of the one or the other hand. Both conditions, moreover, seem to me probably the simple result of the usual location of the speech-center in the left-brain. I

see no reason so far for this left-side placing of the speech-center.

Precision in running, fighting, defense, manipulation, distant vision of enemies, signs, etc., would begin at least early in the history of human savages, and winning in the struggle for existence even so early would depend generally far more on accuracy and perfection of vision than of manual dexterity. I have not been able to conclude as to the existence of any degree of right-handedness or left-handedness or of right-eyedness or left-eyedness, in animals. Beavers and monkeys might possibly show the beginnings of differentiation. In all human beings, of any degree at least of civilization, both facts can be demonstrated. When civilization is present, the demonstration is apparent in the right-handedness of archers, and those using weapons of battle, and especially of gunners. All military regulations require the musket to be brought to the right shoulder in aiming and firing. These and many other right-handed uses and customs, of course, presuppose and make necessary right-eyedness. In mechanical occupations all tools are made for the right-handed. Locomotive engineers sit on the right-hand side of the engine; that this is because of right-eyedness is proved by the fact that the throttle is manipulated by the left hand, the other and the more expert and stronger one being unused during the 'run.' But, if right-eyed, the engineer can see the track and signals better from the right side of the boiler than from the left. The great mystery and the long-discussed problem of the varying usage of the drivers of wagons, carriages, etc., in passing on the right or left, will be explained, I suspect, by right-eyedness. That those afoot always pass to the right, even though the carriages in the same street pass to the left, is explained by the fact that the field of vision in front and the choice of directions are better under the circumstances than it would be with the right-eyed passing to the left. The danger of collision of vehicles makes passing to the left the preferable and safer plan.

When the harp grew into the dulcimer, and that into the piano, the execution of the most important, skilled and difficult part, the melody or air, was of course given to the right-hand side of the key-board, and the easier and accompanying part to the left. But prior to that was the violin, and it is only the theory of right-eyedness that can explain why the most difficult and rapid fingering was given to the more inexpert left hand, and the simpler and easier bowing to the more dextrous right. The advantage was unconsciously recognized and unconsciously applied which comes from the learner's greater ability to see the motions and positions of the fingers with the right eye when the fingering is done with the left hand. The left hand and the neck of the instrument in this position are seen at an angle, and, therefore, more correctly, than would be possible if the right hand were used for fingering and the neck of the violin placed directly in the line of the axis of vision of the right eye. In this case there would be the difficulty and doubt which results from the foreshortening or from looking along a line or surface nearly level with the eye.

The more expert hand in shooting a gun is used for the simple task of pulling the trigger, while the weaker and more awkward left is forced to do the all important tasks of supporting the gun and taking aim or directing the barrel upon the mark. The right eye compels also this reversal of what would otherwise be the natural and unconsciously preferred custom. In chopping, hoeing, shoveling, etc., the weaker left gives the force and direction of the blow, and the right only guides a little the end of the tool, and in general serves a subordinate function. In these occupations the angled axis of vision as in the violin is not necessary, and would even be a disadvantage. Looking downward, as in writing, the right does its work more accurately when straight below.

Any number of similar examples will come to mind of the influence of right-eyedness in every department or phase of our life, and the explanation of a multitude of incongruities and peculiarities observed or hitherto unsuspected will be brought to light. There is hardly any act or custom, personal or social,

that does not give evidences of the influence of right-eyedness.

One wonders if a new clearness will not be brought into neurology and psychology by a careful correlation of the suggestions which the theory offers. The unification and perfection of innervation and cerebration must be better if initiated and executed with the cerebral centers mainly upon one side of the brain, than if the unity is gained by means of the longer and more distant commissural fibers extending between the two sides of the brain. In the right-handed the speech center is in the left side of the brain, as is also the innervational motor center for the right hand, and the optical center of the right eye. The dependence of all motion upon a perfect correlation of vision and judgment needs only to be mentioned. That all intellect is psychologically the product of vision is less recognized, but is not less absolute truth. The right hand writes, possibly because the right eye looks down upon the writing more accurately than would the left; both depend upon the synchronous and closely interrelated guidance of the speech-making function. All three are in closer unity and contiguity than if either were in the opposite side of the skull. A gentleman acquaintance who is left-handed for most things has by training during youth developed the habitual use of the right hand for writing. When he plays billiards he takes aim two or three times as long as others, and makes from six to ten motions with the cue before giving the stroke. One feels that his correlation of vision, judgment and motion is much more difficult than with other players.

In the left-handed, as is well known, the speech center is in the right brain. Hence the left-handed are also left-eyed.

The pathologic presents itself when in the right-handed by heredity or habit, right-eyedness is prevented by a greater ametropia in the right, by accident, injury, cataract, leucoma or other disease which markedly lessens its visual acuity below that of the left. Right-eyedness, however, will persist with considerably greater acuity of the left eye. To be right-handed by heredity and habit, and at the same time left-eyed by disease, etc., brings a doubt and an awkwardness into every act. After a half-life of right-eyed correlations and habits to be suddenly made left-eyed, etc., by disease, accident, or by glasses produces something like tragedy in a patient. Many problems and ill-successes in the practising ophthalmologists' office receive an illuminating explanation by keeping in mind the physiologic fact of right-eyedness and the pathologic consequences of disease, or the result of interfering with it, by spectacle lenses. It may be better for the oculist to leave a person right-eyed rather than to give such lenses as suddenly compel left-eyedness.

For the present I will cite only three illustrative cases:

The first is that of a man who is left-handed in billiard playing and in most occupations. Asked to see if his cue was straight, he brought it before the nose with both eyes open, and thus 'sighted' along it. Asked to sight more accurately, he finally brought it opposite the right eye and closed his left. Asked to observe if two tables were exactly of the same height, he again sighted with the right eye, shutting the left. And he wrote with his right hand. These acts at first seemed to be incongruous, but they were all explained by the fact that his right arm had been broken when he was twelve years of age, and the right-handed acts since then performed with the left have been compelled because of permanent injury of the right arm. Writing being largely a finger-movement, and especially an intellectual act, was continued with the right hand. It has been demonstrated by pathology that the intellectual act of writing proves the location of the speech-center to be in the side of the brain opposite the hand used, although for all other usually right-handed acts the left may be preferred.

The second case is that of a carpenter who is left-handed, and has been so from infancy. He is also left-eyed. During his youth parents and teachers tried to make him right-handed by tying his left hand behind him, etc. As a carpenter he has to use tools, the plane, a vise, etc., made for the right-handed, but he is always awkward when thus com-

pelled to work. After planing a board thus held in a vise, he goes to the other end of it in order to sight down it with his left eye. With this eye he is an excellent judge of levels and straight lines. He steps off with the left foot first. The most remarkable thing about this case is that, although the man is a good hunter and 'an excellent shot,' he, from some unexplained reason, puts the butt of the rifle against his right shoulder. *But he does not sight with his right eye!* He leans his head sufficiently to bring the left eye in the line of the sights, and with this eye only he takes his aim. He chooses highly crooked or angled gun-stocks because of this necessity. The left-eyed, I suspect, will always be found to have some exceptional habits or vestiges of habits still unconquered by the outnumbering and preponderant right-handed ancestry.

The third case is that of a man who has been left-handed from infancy in the use of all instruments, knife and fork, billiard cue, gun, hoe, etc. But so much was he trained and forced to use the right hand in childhood and youth in writing with pen and ink that he now habitually writes with that hand, if using pen and ink. If using a pencil, chalk, etc., he is equally expert with the left and usually prefers it.

I gather that ambidexterity should be discouraged instead of stimulated. If a child prefers left-handedness, there will be a greater celerity and unity by means of the location of the three organs dominating action in one side of the brain.

I have never seen anything but bad results from the attempt to train children to use the right hand instead of the left, when there is a decided tendency or habit to be left-handed. Moreover the attempt is never successful. The best consequences are poor, and are only awkward mixtures of the two forms, which yield confusions and indecisions during the entire subsequent life. The instance of the billiard player of whom I have spoken is one. Another and more striking evil result is that of a naturally left-handed friend, A. V. P., who by arduous and continuous training during his childhood was compelled to write with his right hand. For all other acts he is left-handed but he can not use his left hand for writing. Although now past fifty he has always hated any writing, the mere act of doing so, and he can not do any original thinking while writing. He is for this purpose compelled to rely on a stenographer, and then his ideas flow freely and rapidly. If he tries to think, plan, or devise and to write at the same time there is a positive inhibition of thought and he must make sketches, epitomes, several efforts, copyings, etc., in a painful and most unsatisfactory manner. The attempt at ambidexterity has been a lifelong obstacle to him in his professional progress. The chief centers most closely interrelated in writing and thinking are thus demonstrably better harmonized when in one side of the brain. The mechanics of neurology are plainly less difficult than could be achieved by any foolish and unsuccessful ambidexterity.

As to the appearance of left-handed children of right-handed parents and ancestors, we are, of course, in no scientific stage to explain, any more than we can explain dextrocardia or other embryologic anomalies. Perhaps, as I have suggested, the location of the speech center in the right side of the brain, by some exceptional condition of development is the ultimate cause both of left-handedness and of left-eyedness. The problem of heredity of left-eyedness and right-eyedness would prove a most interesting study by the method of Mendel.

George M. Gould.
Philadelphia, Pa.

STUDENTS AT GERMAN UNIVERSITIES.

The following table, as reported by United States Consul Warner, Leipzig, Germany, shows the number of students attending twenty-one German universities during the winter semester, 1903–4, arranged in the order of their numerical importance:

For the present winter course the total number of matriculated students at the German universities is 37,854, of whom 3,093 are foreigners, the largest number ever recorded. The number of foreign students is equivalent to 8.2 per cent. of the total number.

Name of University.	Matriculated.	Others Attending Lectures.		Total.
		Male.	Female.	
Berlin.....	7,503	5,791	562	13,856
Munich....	4,609	224	22	4,855
Leipzig....	3,772	573	62	4,407
Bonn.....	2,294	103	87	2,484
Breslau....	1,770	111	98	1,979
Halle.....	1,753	160	51	1,964
Tübingen...	1,387	26	3	1,416
Göttingen..	1,370	51	57	1,478
Heidelberg.	1,359	123	53	1,535
Strassburg.	1,333	96	71	1,500
Freiburg...	1,305	156	26	1,487
Würzburg..	1,283	21	75	1,379
Münster....	1,204	55	...	1,259
Marburg...	1,154	74	18	1,246
Giessen....	1,071	38	11	1,120
Erlangen...	982	21	10	1,013
Königsberg.	925	81	67	1,073
Jena.....	816	49	25	890
Kiel.....	758	41	15	814
Griefswald.	687	50	...	737
Rostock....	519	30	...	549
Total....	37,854	7,874	1,313	47,041

Consul-General Guenther, at Frankfort-am-Main, reports further that of these foreigners 739 are studying philosophy, philology or history; 722, medicine; 651, mathematics or natural sciences; 366, law; 231, political economy or forestry; 178, agriculture; 135, Evangelical theology; 32, Catholic theology; 26, dentistry and 13, pharmacy. Two thousand six hundred and twenty of them come from European and 473 from non-European countries. Among the former are 986 from Russia, 588 from Austria-Hungary, 318 from Switzerland, 162 from England, 73 from Bulgaria, 69 from Roumania, 64 from France, 59 from Greece, 55 from Servia, 49 from Holland, 41 from Turkey, 43 from Italy, 33 from Luxemburg, 33 from Sweden and Norway, 14 from Belgium, 13 from Spain, 12 from Denmark, 4 from Portugal, 2 from Montenegro and 1 from the principality of Lichtenstein.

Of the other foreign students, 319 are from America, 133 from Asia, 19 from Africa and 2 from Australia. The Americans are mainly from the United States and the Asiatics for the largest part from Japan.

These figures, however, include only the lawfully immatriculated students; to them must be added those who are enrolled as hospitants, of which 9,187 are reported in the foregoing table, including 7,874 male and 1,313 female attending as special students.

Noteworthy among other things, in the table above, is the numerical preeminence of attendance at Berlin, where the total exceeds that of Munich, Leipzig, Bonn and Breslau combined. But 42 per cent. of Berlin's attendance is made up of non-matriculated students, representing a floating element to a considerable extent. Elsewhere in Germany this feature is a minor one in university attendance.

Among non-matriculated students, one out of every seven is a woman, and over 42 per cent. of these women in attendance at the twenty universities are found at Berlin. Outside of Berlin women students among non-matriculants are best represented at Breslau, Bonn and Strassburg, but at none of these institutions does the attendance reach a hundred.

JOHN FRANKLIN CROWELL.
WASHINGTON, D. C.

RESOLUTIONS OF THE CHEMICAL SOCIETY OF WASHINGTON IN MEMORY OF E. E. EWELL AND E. A. DE SCHWEINITZ.

AT the regular meeting of the Chemical Society of Washington, held in the Assembly Hall of the Cosmos Club on Thursday evening, March 10, 1904, the following memorial was presented by Dr. Harvey W. Wiley and, in accordance with the custom of the society, was ordered spread upon the minutes of the meeting, published in SCIENCE and a copy furnished the family of the deceased:

Mr. E. E. Ewell was a faithful and loyal member of the American Chemical Society and of the Washington Section thereof. At the time of his removal from Washington he was one of the vice-presidents of the section and in direct line to the presidency. For one so young his services to science were notable, and especially so in view of his willingness to engage in laborious routine work which occupied a great part of his time. His activities extended to all branches of agricultural and pharmaceutical chemistry. He organized in the Bureau of Chemistry the investigations of the qualities of the articles offered to the government under contract, and had charge of that part of the work committed to the bureau from the different departments of the govern-

ment. His personality was always agreeable and his friends were quite as devoted to him as those who were drawn to him by scientific ties. He was a manly man, honest, frank and straightforward in his conduct. He was always ready to take an active part in all the social festivities attending scientific reunions and was a welcome guest at a banquet or a smoker. His death removes from the field of scientific labor a faithful worker before he had reached his prime, while still full of promise made more sure by past achievements. As a man, as an investigator, as a coworker and as a friend we mourn his loss.

At the regular meeting of the Chemical Society of Washington held in the Assembly Hall of the Cosmos Club on Thursday evening, March 10, 1904, the following resolutions were presented by Dr. Marion Dorset and, in accordance with the custom of the society, were ordered spread upon the minutes of the meeting, published in SCIENCE and a copy furnished to the family of the deceased.

WHEREAS, We, the members of the Washington section of the American Chemical Society have heard with deep regret and profound sorrow of the sudden and unexpected death of Dr. E. A. de Schweinitz, be it

Resolved, That we hereby record this expression of our grief on account of the loss which we, his colleagues, have suffered, and which the scientific world at large has experienced through his untimely death. As a member and past president of this society he contributed in great measure to its success, and we feel that his death has removed not only a friend but a colaborer who has done much towards the advancement of his chosen profession; be it further

Resolved, That these resolutions be spread upon the minutes of this society and that a copy be furnished his family, to whom we extend our sincere sympathy in their bereavement.

Dr. H. W. Wiley, in seconding the resolutions, said: "Dr. de Schweinitz was first appointed in the Division of Chemistry on August 23, 1888. A full account of his service to science, a list of the papers he has published and his career in medical educational work are found in the proceedings of the memorial meeting held in his honor at Columbian University on Saturday evening, March 7.

"It is not necessary to recapitulate these proceedings here, as they will be published and made available to all his personal and scientific friends."

DEPARTMENT OF INTERNATIONAL RESEARCH IN TERRESTRIAL MAGNETISM OF THE CARNEGIE INSTITUTION.

THE Trustees of the Carnegie Institution at their annual meeting last December authorized the establishment of what is to be known as the 'Department of International Research in Terrestrial Magnetism.' An allotment of twenty thousand dollars ($20,000) was made with the expectation that, if the proposed work should be successfully organized, a similar sum would be granted annually for the period requisite to carry out the plan submitted by the writer, indorsed by leading investigators, and published in the Year Book No. 2 of the Carnegie Institution.

The undersigned has been appointed director of the department, and has been given full authority to organize it beginning with April 1, 1904. Arrangements have also been made so that the magnetic survey and magnetic observatories of the United States, conducted under the Coast and Geodetic Survey, remain in his charge, as heretofore.

The general aim of the work is 'to investigate such problems of world-wide interest as relate to the magnetic and electric condition of the earth and its atmosphere, not specifically the subject of inquiry of any one country, but of international concern and benefit.' The prime purpose, therefore, of this department, is not to *supplant* any existing organization, but rather to *supplement*, in the most effective manner possible, the work now being done, and to enter only upon such investigations as lie beyond the powers and scope of the countries and persons actively interested in terrestrial magnetism and atmospheric electricity.

At first principal stress will be laid upon the complete reduction, discussion and correlation of the existing observational data and upon early publication of the results in suitable form, in order to exhibit the present state of our knowledge. In this way will be revealed the gaps to be filled and the direction

of future and supplementary investigations will be suggested. While, however, this will constitute at first the chief work of the department, it is likewise proposed to embrace favorable opportunities for supplementing, by observation, the existing data and to cooperate with others in the observing of such of the earth's magnetic and electric phenomena as are of momentary occurrence, and the investigation of which is of great importance.

Details as to the method of work to be followed by the department and the investigations undertaken will be made known later. It is proposed that whenever feasible, those having certain pieces of work already in hand will be invited to associate themselves with the department.

A word of explanation as to the 'international' character of the undertaking. As all of the funds are supplied by the Carnegie Institution, it will not be possible to organize this department in accordance with the customs governing organizations the funds of which are contributed by various nations in concert, such, for example, as the International Geodetic Association, the International Catalogue of Scientific Literature, etc. While, however, the basis of organization can not be 'international' in the sense usually defined by such bodies, it is the intention to conduct the work with the counsel of an Advisory Board composed of representative persons, irrespective of country, and in this sense, the department is to be truly 'international.'

That an important step has been taken by the Carnegie Institution, will be patent to all who are interested in the development of our knowledge of the earth's magnetism and electricity. Professor Neumayer, one of the representative investigators who endorsed the undertaking and promised support, expressed himself thus when the project was submitted to the Carnegie Institution:

"I am of opinion that if this plan reaches its fulfilment, it is the most important step ever taken for the development of our knowledge of the earth's magnetism. The thought which underlies it must appeal to every one who has ever been engaged in geomagnetic investigations. In no other branch of geophysics is it more essential to extend the inquiries over the entire earth. Magnetic research, to be successful, requires the cooperation of the most competent investigators of all countries."

All mail intended for the department should be addressed as below. L. A. BAUER.

DEPARTMENT TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION,
WASHINGTON, D. C.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR W. W. CAMPBELL has been elected one of the thirty foreign members of the Italian Society of Spectroscopists.

DR. W. J. HOLLAND, director of the Carnegie Museum, Pittsburg, has been made a corresponding member of the Swedish Society of Anthropology and Geography.

PROFESSOR EUGEN WARMING, of Copenhagen, has been elected a member of the Paris Academy of Sciences in the section of botany.

PROFESSOR L. LUCIANI, of Rome, and Professor A. Mosso, of Turin, the eminent physiologists, have been appointed senators of the realm in Italy.

MM. APPEL, Lenfant and Lebaume-Pluvinet have been elected members of the council of the French Astronomical Society.

DR. W. C. FARABEE, instructor in anthropology at Harvard University, is to conduct a party on an anthropological trip through the west, starting immediately after commencement.

PROFESSOR F. S. EARLE, assistant curator at the New York Botanical Garden, has gone to Cuba, on leave of absence, at the request of the Cuban Government, for the purpose of aiding that government in the establishment of a Department of Agriculture.

PROFESSOR ROBERT KOCH will return to Berlin at the end of June. He is at present at Dar-es-salaam, South Africa, studying malaria and the prevalent cattle disease.

A CHAPTER of the Scientific Society of the Sigma Xi has been established at the University of Illinois with Professor S. A. Forbes as president.

THE staff of the Henry Phipps Institute of Philadelphia, gave a dinner on March 28, at

which Dr. Lawrence F. Flick, director of the institute, was presented with a piece of silver plate.

Dr. M. Salomon has received the Alvarenga prize from the German Hufeland Society for his pamphlet on 'Tuberculosis as a Disease of the Masses and Measures to Prevent it.'

The municipal council of the City of Paris has presented M. and Mme. Curie with silver medals.

Mr. Arthur Thomson, assistant superintendent of the Gardens of the Zoological Society of London, has been presented with the society's silver medal for his services extending over thirty-four years.

Professor Cornil, of Paris, has been presented with a portrait and medallion on retiring from hospital service at the age limit of sixty-five years. Dr. Cornil remains professor of pathological anatomy in the University of Paris.

Dr. Wilhelm Hittorf, the eminent physicist and chemist, for many years professor at Münster, celebrated his eightieth birthday on March 27.

We learn from *Nature* that the Belgian Royal Academy has awarded its gold medal of 1,000 francs to M. Marc de Selys-Longchamps for his memoir on the development of a Pharonis. The Théophile Gluge prize for physiology has been awarded to Dr. P. Nolf, of the University of Liège.

Professor Wilhelm Ostwald will give at the Royal Institution, London, the Faraday lecture before the Chemical Society on April 19.

The Croonian lecture of the Royal Society was delivered on March 4, by Professor E. H. Starling, F.R.S., and Dr. W. M. Bayliss, F.R.S., the subject being 'The Chemical Regulation of the Secretory Process.' Professor E. Rutherford, of McGill University, will give in May the Bakerian lecture, on 'The succession of changes in radioactive substances.'

The following are among the lecture arrangements at the Royal Institution: Professor L. C. Miall, three lectures on 'The Transformations of Animals'; Mr. L. Fletcher, three on 'Meteorites'; Mr. H. F. Newall, two on the 'Solar Corona'; Professor Dewar, three on 'Dissociation'; and Sir W. Martin Conway, two on 'Spitzbergen in the Seventeenth Century.' The Friday evening meetings will be resumed on April 15, when Mgr. Count vay de Vaya and Luskod will deliver a discourse on 'Korea and the Koreans.'

Dr. Henry Milton Whelpley, professor of materia medica and pharmacy, Medical Department, Washington University, and of microscopy, St. Louis College of Pharmacy, delivered by invitation the valedictory address at the Pharmacy Department of Purdue University, on March 30.

A memorial has recently been erected to Max Schede in the grounds of the clinic at Bonn. The address was delivered by his successor, Professor Bier.

Mr. Henry L. Marindin, hydrographer connected with the United States Coast and Geodetic Survey since 1863 and a member of the Mississippi River Commission, has died at the age of sixty.

The death is also announced of M. Jules Garnier, known as a geologist and metallurgist, at the age of sixty-five years, and of Captain Deburaux, known for his aeronautical experiments at the age of forty years.

The A. W. Anthony collection of birds has been purchased by the Carnegie Museum, Pittsburg. The collection contains ten thousand specimens, including the types of all the species and subspecies described by Mr. Anthony. Mr. C. V. Hartman, the curator of archeology and ethnology in the museum, has removed the collection of Costa Rican antiquities made by Padre Jose Maria Velasco from the Archeological Department of the Free Museum of Science and Art in West Philadelphia to the Carnegie Museum at Pittsburg. This collection, together with another scarcely less important collection made by Padre Velasco, supplemented by the Troyo, the Ferraz and other collections recently acquired by the museum, give this institution the largest assemblage of Costa Rican antiquities in existence outside of Costa Rica. In fact, the Carnegie Museum possesses more

specimens of Costa Rican antiquities than are found in all the museums of the world put together.

AT a meeting held at the College of Physicians at Philadelphia on March 28, steps were taken to effect the organization of the United States Association for the Study of Tuberculosis, and Drs. E. L. Trudeau, George M. Sternberg, W. H. Welch, L. F. Flick and H. M. Biggs were appointed members of the committee. Dr. Wm. Osler was chosen chairman and Dr. H. Barton Jacobs, secretary for the committee, when it shall meet in connection with the American Medical Association at the annual session in June at Atlantic City.

THE American Neurological Association will hold its meeting at St. Louis on September 15, 16 and 17 immediately preceding the sessions of the various medical departments of the Congress of Arts and Sciences, beginning September 19.

OWING, it is said, to the war in the east, the Congress of Polish Scientific Men and Physicians will not meet at Lemberg this year, as has been announced.

A REUTER telegram from Vienna, dated March 19, states that at the request of the Academy of Science, the Austrian Minister of Agriculture, in order to facilitate the solution of certain important questions relating to the nature of radium, has ordered that from January 1 last until further notice no trading should be permitted in the residues from the manufacture of uranium colors at Joachimsthal, and that 10,000 kilograms of those residues should be reserved for purchase by the academy and another 10,000 kilograms for M. Curie, the discoverer of radium, in Paris. These consignments are to be devoted entirely to the purpose of scientific experiment.

M. DEUTSCH, having offered a prize of $25,000 for the first flying machine making a flight in a circle of one kilometer, M. Ernest Archdeacon has added a like sum and has appealed for further subscriptions.

THE electric railway at Nice having interfered with the magnetic observations of the observatory, suit was brought by M. Bischoffsheim, and damages have been awarded to the amount of about $20,000.

THE Civil Service Commission invites attention to the following named scientific and technical examinations to be held on April 19, 1904, with the statement that but few applications have been filed therefor:

Aid, Coast and Geodetic Survey.
Civil and electrical engineer.
Civil and electrical engineer, Philippine Service.
Civil engineer, Philippine Service.
Civil engineer and draftsman.
Architectural computer (Supervising Architect's Office).
Computer, Nautical Almanac Office.
Computer, Naval Observatory.
Deck officer, Coast and Geodetic Survey.
Topographical draftsman (Land Office Service).
Library assistant.
Manual training teacher.
Trained nurse, Philippine Service.

As the commission has experienced considerable difficulty in securing eligibles for the positions named, qualified persons are urged to enter the examination. Those who desire to compete should at once apply to the United States Civil Service Commission, Washington, D. C., for a copy of the Manual of Examinations and the necessary forms of application.

UNIVERSITY AND EDUCATIONAL NEWS.

THE assembly has passed a bill appropriating $250,000 for the New York State College of Agriculture at Cornell University.

PRESIDENT C. E. MILLER, of Heidelberg University, Tiffin, Ohio, announced on March 24, that he had secured pledges to the amount of $150,000 for the fuller equipment of the university, $50,000 of this amount to be expended in buildings and $100,000 to be added to the permanent endowment.

A LADY, who has requested that her name be not made known, has given $40,000 for the erection of a dormitory for the women students at Colby College, Waterville, Me.

MR. ANDREW CARNEGIE has given $30,000 to Berea College in Kentucky. The trustees of the institution are preparing to test the constitutionality of the law recently passed forbidding coeducation of the races. It is also

reported in the newspapers that Mr. Carnegie has donated library buildings to Winthrop College, at Rock Hill, S. C., and to Converse College, at Spartanburg, S. C., both colleges for women.

The Court of Appeals has affirmed the judgment of the lower courts in deciding that New York University has no title to the lands or properties of the Loomis laboratory at 414 East Twenty-sixth Street. The laboratory was founded with $100,000, contributed by Dr. Alfred L. Loomis in 1887; its properties are now valued at $200,000.

The College of Pharmacy of the City of New York celebrated its seventy-fifth anniversary on March 29, by approving an agreement with the trustees of Columbia University whereby, after July 1, it becomes a part of the latter institution. Under the agreement the finances of the College of Pharmacy will remain in the control of its trustees, although the president of Columbia will be its ex-officio president. The present course of instruction will remain unchanged until the fall of 1905, when changes are to be made and approved by the officers of Columbia. The standard of admission to the College of Pharmacy, it is expected, will be raised. Students graduating as 'graduates of pharmacy' are not to receive the university degree, that being conferred only on doctors of pharmacy and post-graduates, who have passed the regents' examination.

It is expected that the new Agricultural Hall, now under construction at Clemson College at a cost of about $50,000, will be completed during the summer and ready for occupation by the opening of the next session. This building will provide class-rooms and laboratories for instruction in agriculture, horticulture, botany and bacteriology, zoology and entomology, veterinary science, and geology and mineralogy, besides a natural history museum. The state legislature, at its recent session, also established 124 agricultural scholarships at a value of $100 each.

The Oxford convocation has passed a decree accepting with gratitude a donation by Pandit Shyámaji Krishnavarmá, M.A., of Balliol College, for the establishment of an endowment in memory of the late Herbert Spencer, the endowment to take the form of an annual lecture, with a provision that a 'Herbert Spencer' prize may, if desired, with the consent of the founder during his lifetime, be substituted for the lecture.

The trustees of Carleton College at Northfield, Minn., have appointed the Rev. Dr. George R. Montgomery, lecturer on philosophy at Yale University, to be professor of philosophy, *vice* the Rev. E. W. Lyman, who goes to the Congregational Theological Seminary at Montreal.

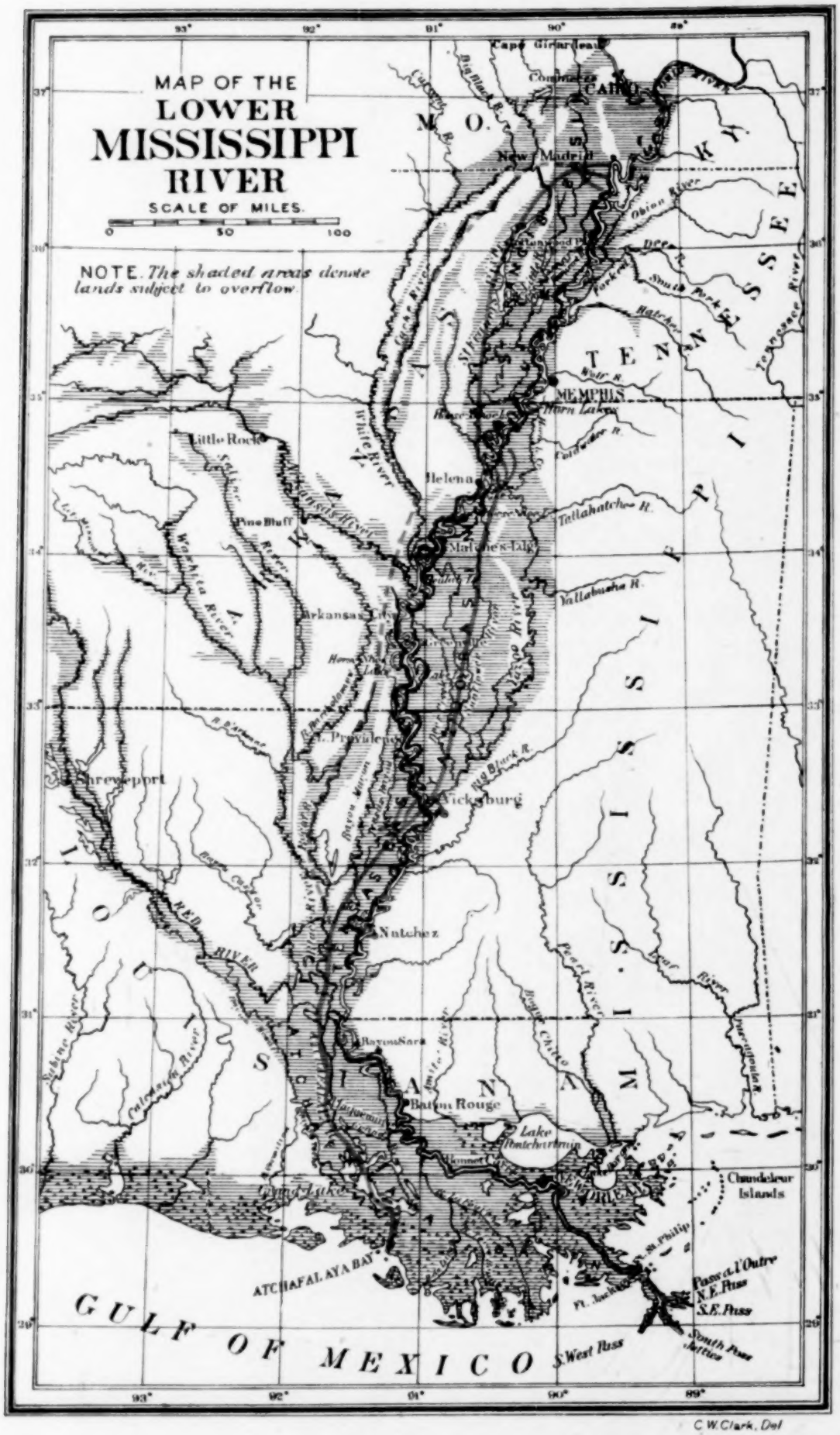
J. Volney Lewis, professor of geology and mineralogy in the Clemson Agricultural College of South Carolina, has resigned to accept a similar position in Rutgers College after the close of the present session.

Mr. J. E. Burbank, B.A. (Bowdoin), M.A. (Harvard), has resigned his instructorship in physics at the University of Maine, to accept a position in the Magnetic Survey, at Washington, D. C. Mr. L. E. Woodman, A.B. and A.M. (Dartmouth), formerly assistant in physics at Dartmouth, has been elected to the vacant instructorship.

The following appointments have been made at Harvard University: *Instructors*—O. Ames and J. M. Greenman in botany, A. B. Frizell in mathematics, J. A. Moyer in descriptive geometry, S. E. Whiting in electrical engineering, P. S. Smith in geology, and H. C. Boynton in metallurgy and metallography. *Assistants*—N. S. Bacon, L. S. Hapgood, P. H. Provandie, in hygiene; A. B. Plowman in botany, O. F. Black, J. F. Langmaid, A. D. Wyman in chemistry, and J. N. Bell in zoology. *Austin teaching fellows*—L. Ross in applied mechanics, A. H. Chivers in botany, A. Tyng in engineering, and A. E. Norton in mechanical drawing and mathematics.

Mr. Anthony Traill, M.D., LL.D., has been appointed provost of Trinity College, Dublin, in succession to the late Dr. George Salmon.

Kotaro Shimomura, a graduate of the Worcester Polytechnic Institute, has been elected president of Doshisha College, Kioto, Japan.


MAP OF THE
LOWER
MISSISSIPPI
RIVER
SCALE OF MILES.
0
50
100
NOTE. The shaded areas denote lands subject to overflow
Cape Girardeau
CAIRO
New Madrid
Obion River
Forked Deer R.
South Fork
Hatchee
Tennessee River
MEMPHIS
Horn Lake
Little Rock
White River
Helena
Pine Bluff
Arkansas City
Tallahatchee R.
Yallabusha R.
Big Black R.
Vicksburg
Shreveport
Natchez
Pearl River
Bogue Chitto
Bayou Sara
Baton Rouge
Lake Pontchartrain
NEW ORLEANS
Chandeleur Islands
Calcasieu River
Sabine River
Grand Lake
ATCHAFALAYA BAY
GULF OF MEXICO
Pass a l'Outre
N.E. Pass
S.E. Pass
South Pass
S. West Pass
MISSOURI
KENTUCKY
TENNESSEE
MISSISSIPPI
LOUISIANA
ARKANSAS
TEXAS
93°
92°
91°
90°
89°
37°
36°
35°
34°
33°
32°
31°
30°
29°

C.W. Clark, Del